
ATTACHMENTS TO THE SPECIAL PROVISIONS

MNDOT PERMIT LONG FORM TP-2525

April 5, 2013

TO: Thomas Streiff
MnDOT Permits
2900 48th St NW
Box 6177
Rochester, MN 55901-5848

Mail to: Thomas.Streiff@state.mn.us

Office 507-286-7592
Cell 507-273-8677
Fax 507-286-7660

Subject: State No SP 159-123-007 (055-625-024)
Federal No STPX 5513 ()
City No 6301-3-97, J7267
Reconstruct 16th Street SE from South Broadway (TH 63) to 3rd Avenue SE

Enclosed please find:

1. Application for Installation of Utilities or Miscellaneous Work on a Trunk Highway Right of Way Long Form TP-2525.
2. 2-copies of the Plan Sets, for the project referenced above.

The project is scheduled for construction this summer.

Please route for your review and comments.

Sincerely,



Russell Keim, PE
Design Engineer
Dept Public Works, Room 108
201 4th Street SE
Rochester, MN 55904
W: 507 328-2417
F: 507 328-2401
Email: rkeim@rochestermn.gov
Enclosure application and (2 plan)

P:\PROJECTS\J-PROJ\J7267\Design\Docs\MnDOT permit\Cover letter MnDOT permit.docx



**INSTRUCTIONS FOR COMPLETING APPLICATION FOR UTILITY PERMIT
ON TRUNK HIGHWAY RIGHT OF WAY
LONG FORM TP-2525**

Note: An incomplete application will delay processing.

Long Form TP-2525 is used for the vast majority of utility placements and relocations. Form 2525 is for placing, constructing, and reconstructing utilities within trunk highway right of way, whether longitudinally, oblique, or perpendicular in relationship to the centerline of the highway (utilities crossing the highway, or parallel installations). This form is sent to the St Paul office for processing.

Form TP-1723 (short form) is for minor work such as installation of utility service connections that do not cross or parallel the roadway within the trunk highway right of way. This form is also used for installing miscellaneous guy wires and anchors, to place temporary obstructions on the right of way, to perform temporary relocations of a more minor nature, and to accommodate a construction project. This form is sent to the District offices for processing.

Fill Out Form Completely, be specific

Print (in ink), type the application, or fill out on line and print form at: www.dot.state.mn.us/utility/forms/index.html

- Be sure to sign it at the bottom. Submit the original form only; submit all 3 pages of application.
- **COPIES AND FAXES ARE UNACCEPTABLE AND WILL BE RETURNED TO YOU.**

Submit the following information:

- One permit application form completed in its entirety, if an item does not apply, print "N.A." in the blank,
- Two sets of sketches, no larger than 11 x 17.
- Drawn to a scale no smaller than 1 inch = 200 feet
- Include a typical of all pole structures, if applicable
- A separate application for each trunk highway
- A separate application for each maintenance area involved

The sketch must show in detail the proposed location of any facilities to be placed as well as any relocation of existing facilities. The sketches must be on state right of way maps or state construction plan sheets. Right of way maps are available at:
http://dotapp7.dot.state.mn.us/cyberdocs_guest/

The sketch must contain references from the trunk highway centerline or the right of way line and a starting and ending point must be given. If there is no right of way map available a detailed drawing must be submitted with distances given from pertinent features such as centerline, right of way lines, curb and gutter, distances from nearest county roads and highway mile markers, etc.

Indicate any tree trimming and/or clearing requirements. If the facility being placed is an aerial facility, include "blow out zone" (conductor movement envelope) information. A vegetation management plan must be worked out with the District office.

If you have questions filling out the form you may contact Central Office Permits for assistance. Contact information can be found at:
www.dot.state.mn.us/utility/contacts.html

After the application has been completed, signed and dated, mail the application (all 3 pages of form) with the required plans to the St Paul office at: Minnesota Department of Transportation, Utility Permits Unit – Mailstop 678, 395 John Ireland Blvd, MN, 55155.

After the Permit has been approved

The applicant will be notified of the approved permit and of the amount of security deposit requested. The permit will have special provisions indicating the construction requirements. Read and observe these instructions during construction operations. A copy of the permit must be in the possession of the utility contractor while working on Mn/DOT right of way.

Security Deposit

A security deposit is required for permits that authorize work in state right of way to ensure that work is completed to Mn/DOT's satisfaction. The actual amount required will depend on the specific situation. The District Permit Office will determine the amount and type of deposit to be submitted, (if applicable), payable to the Minnesota Commissioner of Transportation. Minnesota rules require that deposits be submitted in the form of a certified check, cashier's check, or surety bond payable to the Minnesota Commissioner of Transportation. Deposits must be irrevocable and cannot expire.

After construction is completed

After construction has been completed and all turf items re-established, the applicant must return the certificate of completion form to the District Permit Office for final inspection. If all work is satisfactory, the District Permit Office will determine when the deposit will be returned to the applicant.

Mn/DOT TP-2525 (revised 05-2012)		Page 1
STATE OF MINNESOTA DEPARTMENT OF TRANSPORTATION APPLICATION FOR UTILITY PERMIT ON TRUNK HIGHWAY RIGHT OF WAY		SUBMIT 1 (ONE) COMPLETED FORM WITH 2 (TWO) SETS OF SKETCHES, NO LARGER THAN 11 x 17 TO: Utilities Engineer - MS 678 Minnesota Department of Transportation Transportation Building 395 John Ireland Blvd. St. Paul, MN 55155-1899
INSTRUCTIONS TO APPLICANT	1. Complete only page one (no photocopies) 2. Sign completed form 3. Include 2 (two) sets of sketches, no larger than 11 x 17	
County <u>Olmstead</u>	HWY No. <u>63</u> SEC. <u>11</u> TWP. <u>106</u> RGE. <u>14</u>	Company Project No. _____ Agreement No. _____ State Project No. _____
<input type="checkbox"/> New Facility <input checked="" type="checkbox"/> Replacement Facility		
City/Township <u>Rochester</u>		
WILL THIS FACILITY BE WITHIN TRIBAL LANDS <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No IF YES, WHICH ONE		
Application is hereby made for permission to place, construct and thereafter maintain a: 12" Watermain and Roadway Reconstruction, including Traffic Signal		
Across _____ Trunk Highway No. <u>TH 63 South Broadway</u> (Along, Across, Along & Across)		
Location: <u>Intersection of 16th St SW and Broadway</u> 0 _____ feet from center line on the _____ side of the trunk highway as shown on the attached sketch. (North-South-East-West)		
I. AERIAL CONSTRUCTION (Check appropriate box)		BLOW OUT ZONE INFORMATION (Conductor Movement Envelope)
<input type="checkbox"/> Single pole <input type="checkbox"/> Open wire <input type="checkbox"/> H-Frame <input type="checkbox"/> Cable <input type="checkbox"/> Single pole & H-Frame <input type="checkbox"/> Vertical <input type="checkbox"/> Steel tower <input type="checkbox"/> Cross-arm <input type="checkbox"/> Existing pole line <input type="checkbox"/> Vertical & Cross-arm <input type="checkbox"/> Other _____		LIGHTING Mounting Height _____ Mast Arm Length _____ Type of Lamp _____ Watts _____ Poles <input type="checkbox"/> Breakaway <input type="checkbox"/> Non-Breakaway
Voltage _____	Number of Conductors _____	Size of Conductors _____
If attaching to existing pole line, owner of pole line: _____		Minimum height of conductor: ft. along highway _____ ft. at crossings over highway _____
II. UNDERGROUND CONSTRUCTION		
<input checked="" type="checkbox"/> Direct Buried <input type="checkbox"/> Other (explain) _____		Will Facility be attached to a bridge? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Voltage _____	Number of Conductors-Type _____	Size of Conductors, Cable _____ Depth _____
CONDUIT <input type="checkbox"/> Plastic (type) _____ <input type="checkbox"/> Steel pipe _____ <input type="checkbox"/> Multiple tile _____ <input type="checkbox"/> Clay tile _____ <input type="checkbox"/> Sectional concrete _____ <input checked="" type="checkbox"/> Ductile Iron _____ <input type="checkbox"/> Other _____	FACILITY TYPE Max. Oper. Pres. _____ Wall thickness _____ Grade _____ Class _____ Size _____ Depth _____ Number _____	CASING <input type="checkbox"/> Steel pipe _____ <input type="checkbox"/> Sectional Concrete _____ <input type="checkbox"/> Other _____ Wall thickness _____ 0.500 Grade _____ 35,000 psig Class _____ Size _____
METHOD OF INSTALLING UNDER ROADBEDS (if open trench, explain why necessary) <input type="checkbox"/> Directional Boring <input type="checkbox"/> Jacking <input type="checkbox"/> Boring <input type="checkbox"/> Pneuma Gopher <input checked="" type="checkbox"/> Open trench <input type="checkbox"/> Other _____		
III. EXTENT & LOCATION OF TREE TRIMMING AND/OR CLEARING:		
V. Work to start on or after _____ and to be completed on or before _____ V. The applicant, in carrying on all of the work mentioned above or referred to in its application and in the Permit for construction issued therefore, shall strictly conform to the terms of the Permit, and the Rules of the State of Minnesota as set forth in Minnesota Rules 1983 as of July 31, 1983 together with the Special Provisions, all of which are made a part hereof. The applicant specifically agrees to be bound hereby. The applicant shall also comply with the regulations of all other governmental agencies for the protection of the public. The work shall be accomplished in a manner that will not be detrimental to the highway and that will safeguard the public.		Owner of Facility <u>City of Rochester Public Works</u> (Applicant) <u>J7267 Russ Kelm</u> Address <u>201 4th Street SE, Room 108</u> City <u>Rochester</u> State <u>MN</u> Zip <u>55904</u> Telephone <u>507-328-2417</u> E-mail <u>rkelm@rochestermn.gov</u> By <u>Russell Kelm, Design Engineer</u> (Name and Title)
Date <u>03/25/2013</u> Signature <u>Russell J. Kelm</u> Pursuant to Minnesota Statutes, Section 161.45, the following Rules have been promulgated by the Commissioner of Transportation (see pages 2 & 3).		



MINNESOTA RULES

1983

Adopted as of July 31, 1983

UTILITIES EQUIPMENT

8810.3100 DEFINITIONS.

Subpart 1. Interstate highways. Under this order "interstate highways" shall mean all trunk highways which are a part of the interstate system.

Subp. 2. Noninterstate highway. Under this order "noninterstate highways" shall mean all trunk highways which are not a part of the interstate system.

Subp. 3. Trunk highways. Under this order "trunk highways" shall mean all trunk highway including those which are a part of the interstate system.

Subp. 4. Utility. Under this order "utility" shall mean and include all privately, publicly, or cooperatively owned communication lines and facilities, any systems, lines, and facilities for the distribution and transmission of electrical energy, oil, gas, water, sewer, steam, and other pipe lines, railways, ditches, flumes, or other structures which under the laws of this state or the ordinance of any village or city may be constructed, placed, or maintained across, along or on trunk highway right-of-way. Dependent upon the meaning intended in the context, "utility" shall also mean the utility company, inclusive of any wholly owned subsidiary.

Statutory Authority: MS §161.45

8810.3200 PURPOSE AND SCOPE.

Subpart 1. Purpose. The purpose of parts 8810.3100 to 8810.3600 is to carry out the mandate of the legislature and to effectuate that mandate as set forth in the Laws of Minnesota 1959, chapter 500, article II, section 45 (Minnesota Statutes, section 161.45) with reference to the placing, constructing, reconstructing, and maintaining of utilities across, along, upon or under the right-of-way of trunk highways.

Subp. 2. Scope. The scope of parts 8810.3100 to 8810.3600 is confined within the framework of and consistent with the Laws of Minnesota 1959, chapter 500, article II, section 45.

Statutory Authority: MS §161.45

8810.3300 PERMITS.

Subpart 1. Construction. Except as otherwise permitted, utility construction and relocation on trunk highway right-of-way shall not be commenced until an application for a permit for construction has been made and such permit granted. The permit for construction sketch shall show the location of the proposed utility with reference to pertinent features such as the right-of-way lines, curb lines, trunk highway center line, etc. A copy of the sketch shall be provided for each copy of such permit. Prints of trunk highway right-of-way maps available upon request from the Road Plans Information Office, Department of Transportation Building, Saint Paul, Minnesota 55155.

Subp. 2. Maintenance. The utility shall obtain a work permit from the office of the assistant district engineer, maintenance, prior to performing service and maintenance operations on the interstate highways and shall also obtain a work permit prior to performing service and maintenance operations on the noninterstate highways when such operations require opening and disturbing the surface of the right-of-way thereof. In all other instances the utility shall notify the office of the assistant district engineer, maintenance, prior to performing service and maintenance operations on the non interstate highways which interfere with the normal flow of traffic thereon. However, the company may perform service and maintenance operations on the trunk highways including opening and disturbing the surface of the right-of-way without a work permit in those instances where an emergency exists that is dangerous to the life or

safety of the public and which requires immediate repair. The utility upon knowledge of such an emergency shall immediately notify the State Patrol Division. The utility shall take all necessary and reasonable safety measures to protect the traveling public and shall cooperate fully with the State Patrol Division to that end. The utility in such an event will request a work permit from the office of the assistant district engineer, maintenance, not later than the second working day thereafter when a work permit would ordinarily have been required but for the emergency.

Subp. 3. Orders to make improvements. If at any time the state of Minnesota, acting through its commissioner of transportation, shall deem it necessary to make any improvements or changes on all or any part of the right-of-way of trunk highway which affect a utility located on trunk highway right-of-way, then and in such event, the owner of the utility shall within 15 days after written notice from the commissioner of transportation or his duly authorized agent, proceed to alter, change, vacate, or remove said utility from the trunk highway right-of-way so as to conform to said trunk highway changes and as directed by the commissioner of transportation. Such work shall be done without any cost whatsoever to the state of Minnesota except as otherwise provided by law or agreement and shall be completed within the date specified in said written notice, which date shall be reasonable under the circumstances. The utility shall assume all liability and save the state of Minnesota harmless from any and all claims of damage of any nature whatsoever occasioned by reason of not having removed said utility within the time specified in said notice. Notwithstanding the provisions of parts 8810.3100 to 8810.3600, the state may reimburse a municipality for the cost of the first relocation of a municipally owned utility located within the limits of a municipal street at the time that the street was taken over by the State as a trunk highway, when such relocation is required by construction or reconstruction of the trunk highway.

Subp. 4. Along interstate highways. Utilities along interstate highways shall be located outside the control-of-access lines except as outlined below. Where the control-of-access lines coincide with the right-of-way lines, the utilities shall generally be located on private property. Where the control-of-access lines and right-of-way lines do not coincide, utilities may in general be located in the area between them. All utilities shall be serviced and maintained without access from the ramps, loops, and through traffic roadbeds. Utilities may be serviced from frontage roads and roads other than another interstate highway which cross either over or under the interstate highway. At aerial crossings of an interstate highway, supporting poles may be located on interstate highway right-of-way if they are a minimum of 30 feet beyond the shoulders of all through traffic roadbeds; however, in no event shall they be located in a median unless its width is 80 feet or more. Manholes and other points of access to underground crossings may be permitted on the interstate highway right-of-way only when located outside the shoulders of the through traffic roadbeds, loops, or ramps. The restrictions of this subpart shall not apply to utility lines which service facilities required for operating the interstate highway.

There may be extreme cases where, under strictly controlled conditions, a utility may be permitted inside the control-of-access lines along an interstate highway. In each case there must be a showing that any other utility location is extremely difficult and unreasonably costly to the utility consumer, that the installation on the right-of-way of the interstate highway will not adversely affect the design, construction, stability, traffic safety, or operation of the interstate highway and that the utility can be serviced without access from through traffic roadbeds, loops, or ramps.

Subp. 5. Deposit, bond, or undertaking. The commissioner of transportation may require the utility, or its contractor, to furnish a deposit in the form of a certified check, a surety bond or corporate undertaking in favor of the state of Minnesota, commissioner of transportation, for any expense incurred by the state in the repairing of damage to any portion of the trunk highway right-of-way caused by work performed under a work permit or a permit for construction, including any out of the ordinary engineering supervision and inspection expense provided by the state. In those instances wherein a deposit is required, the amount of the deposit shall be specified in the special

provisions of the permit. If a check is furnished, any moneys remaining over and above such expense shall be returned to the applicant.

Subp. 6. Liability. Except for the negligent acts of the state, its agents, and employees, the utility shall assume all liability for, and save the state, its agents and employees, harmless from, any and all claims for damages, actions, or causes of action arising out of the work to be done herein and the continuing uses by the utility, including but not limited to the placing, constructing, reconstructing, maintaining, and using of said utility under this application and permit for construction.

Subp. 7 No easement. The work permit or permit for construction as issued does not in any way imply an easement on private property.

Statutory authority: MS §161.45

8810.3400 STANDARDS FOR WORK CONDUCTED UNDER PERMIT.

Subpart 1. Trees, brush, and vegetation. At the time of construction of the utility and at the times of subsequent maintenance, prior approval shall be obtained from the district engineer or his authorized representative for the cutting and trimming of trees within the trunk highway right-of-way. Wherever trees are cut the resulting stumps shall be removed unless otherwise provided in the special provisions of the permit for construction. Any holes caused by stump removal shall be backfilled, the area leveled, and all materials associated therewith disposed of outside the trunk highway right-of-way. The utility shall advise the district engineer or his authorized representative at least 48 hours in advance of its intent to start clearing and grubbing operations so that the proper supervision can be provided.

Burning or diskings operations and/or the use of chemicals to control or kill trees, brush, and other vegetation is prohibited without prior approval from the assistant district engineer, maintenance.

Subp. 2. Waterways. All waterways and lines of drainage shall remain operative.

Subp. 3. Topsoil and sod. Wherever topsoil and sod are disturbed they shall be replaced and maintained satisfactorily until the turf is established.

Subp. 4. Existing utility facilities. The utility facility and installation shall not interfere with any existing utility facilities on the trunk highway right-of-way.

Subp. 5. Warning devices. When necessary, barricades, warning devices and flagmen shall be provided by the utility during all phases of their construction and maintenance operations on the trunk highway right-of-way.

Subp. 6. Restoration to original condition. Upon completion of an installation, the utility shall restore the trunk highway right-of-way to its original condition. The utility shall then notify the office of the assistant district engineer, maintenance, or project engineer of the completion of the work so that inspection can be made to determine its acceptability.

Subp. 7. Conformity. The installations shall be made in conformity with all applicable laws, rules, and codes covering said installations. All installations shall be made in conformity with rules of governmental agencies for the protection of the public.

Statutory Authority: MS §161.45

8810.3500 AERIAL LINES.

There shall be only a single pole line on the trunk highway right-of-way on either side of the center line thereof, unless otherwise authorized in the special provisions of the permit for construction.

Longitudinal installations on noninterstate trunk highways shall normally be located in the outer five feet of the right-of-way. At crossings of the noninterstate trunk highway, poles shall be placed at a minimum of 30 feet from the shoulder lines of the through roadbeds unless right-of-way widths are prohibitive to such location. Unless clearly indicated on the permit for construction sketch, the location of all brace poles, anchors, and anchor poles within the limits of the trunk highway right-of-way shall be approved by the district engineer or his authorized representative prior to actual installation. In those instances in which a utility is issued a permit or permits for construction on both sides of the trunk highway right-of-way in a given area such permit is conditioned upon the utility subsequently providing joint use to other utilities upon reasonable terms mutually agreeable to the utilities.

Statutory Authority: MS §161.45

8810.3600 UNDERGROUND LINES.

All crossings of the roadbeds of the trunk highway shall be made by boring inside a casing or carrier pipe, or by jacking, unless this procedure is modified in the special provisions of the permit for construction. The auger shall not lead the casing or carrier pipe by more than one inch. Open trenching shall be restricted to the area from five feet beyond shoulder to the right-of-way line except as modified in the special provisions of the permit for construction.

When pipes with bells and flanges are installed, the crossings of the roadbeds of trunk highway shall be made by boring inside a conduit, as provided in the preceding paragraph, of jacking a conduit of sufficient diameter to permit threading the carrier pipe through it.

All voids caused by jacking or boring shall be filled by pressure grouting. The grout material shall consist of a sand-cement slurry of at least two sacks of cement per cubic yard and a minimum of water to assure satisfactory placement. The underground utilities shall be so installed as virtually to preclude any necessity for disturbing the roadbeds to perform maintenance operations.

Underground installations shall be accomplished without damaging or destroying the principal root structure of specimen trees.

Statutory Authority: MS §161.45

NOTE:

As used in Minnesota Rules, Utilities Equipment, part 8810.3100 Definitions, Subpart 1, interstate highways shall include all Interstate Highways and Federal Aid Freeways.

ENCLOSE SKETCHES



TEMPORARY RAISED PAVEMENT MARKERS (TRPMs)

TRPMs may be used to simulate solid lines without the use of any other pavement marking material and may be used to supplement other types of pavement markings.

TRPMs shall not be used as an interim pavement marking between October 1 and May 1 because of snowplowing operations.

Simulating a Solid Line and a Broken Line

When TRPMs are used to **simulate** a line the following guideline applies, unless otherwise indicated in the Plan or directed by the Engineer:

- Broken Line - place two (2) TRPMs per 2-meter-skip stripe, 2 m on center, and eight (8) meter gap (**use four (4) TRPMs per 10-foot skip strip, 3-1/3 feet on center and 40 foot gap**). The same spacing shall be used whether the marking is for an interim or long-term situation.
- Solid Line - place TRPMs, 3 m (10 foot) on center for tangent sections; place TRPMs, 1.5 m (**5 foot**) on center for curve sections over six (6) degrees (**291-m radius**), steep grades, and concrete pavements.
- Double Solid Line - place two (2) TRPMs separated by 100 mm (**4 inches**) side-by-side using the same spacing required for Solid Lines.

Refer to the details on Page 2 of 2.

Supplementing a Solid Line and a Broken Line

In the following situations, TRPMs do not provide adequate simulation of solid lines and shall only be used to Supplement Solid Lines:

- Areas where the markers, even 1.5 m (**5 foot**) on center, become visually separated. This occurs frequently on low speed urban highways with sharp curves and short transition areas. This also occurs where there are steep grades and dips.
- Areas with high ambient lighting which may diminish the retroreflective capabilities of the markers.
- When TRPMs are used to supplement a line, the following guideline applies, unless otherwise indicated in the Plan or directed by the Engineer:
- Solid Line - place TRPMs, 3 m (**10 foot**) on center.
- Double Solid Line - place two (2) TRPMs separated by 100 mm (**4 inches**) side-by-side, using the same spacing required for Solid Lines.
- Broken Line – place two (2) TRPMs to supplement each broken line segment.

Types of TRPMs

The TRPMs are classified into four types as follows:

- TRPM Type 1 - These markers are acceptable for use on all roadways for short or long term projects. They may be used to supplement or simulate solid or broken lines.
- TRPM Type 2 - These markers are acceptable for use on projects with Average Daily Traffic (ADT) of less than 3,000. They may be used to supplement or simulate solid or broken lines.
- TRPM Type 3 - These markers are acceptable for use on all roadways for short or long term projects. They may be used to supplement solid or broken lines. These markers are **NOT** acceptable to simulate solid or broken lines. If these markers do not conform to the color requirements herein they shall not be placed directly on the pavement marking line.
- TRPM Type 4 - These markers are acceptable for use on chip or sand sealing operations. These markers are designed to be placed prior to the sealing operation with a protective cover that is removed after the seal coat is applied.

TRPM 03/02/06

A list of approved raised pavement markers of each type is available on the Qualified Products List (QPL) for Work Zones, posted on the Office of Traffic, Security and Operations website at <http://www.dot.state.mn.us/trafficeng/products/index.html>

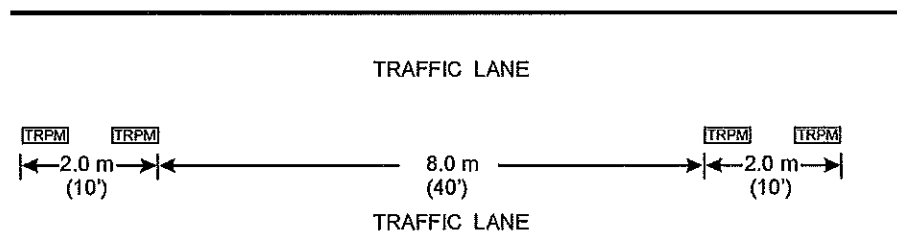
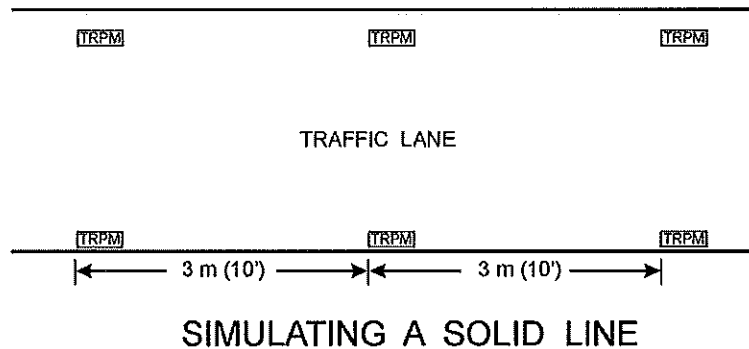
Installation, Maintenance And Removal

Installation, maintenance and removal of the TRPMS shall be done on a continuous basis as directed by the engineer. the contractor shall remove all containers, wrappers and used or damaged markers, etc. from the job site at the time of installation, during the project, and at the time of removals. ALL TRPMS shall be new and unused when placed.

Damaged or missing TRPMS shall be replaced by the contractor within twenty-four (24) hours after notification by the engineer, at no cost to the department.

Prior to installing TRPMS, the pavement surface shall be air blown or brushed to remove surface dust and dirt. the TRPMS shall then be fixed to the pavement surface as per the manufacturer's recommendation.

page 2



SIMULATING A BROKEN LINE (10 m (50') CYCLE)

Page 2 of 3



SPECIFICATIONS for TEMPORARY RAISED PAVEMENT MARKERS (TRPMS)

This specification provides four types of Temporary Raised Pavement Markers (TRPMs) for use in highway work zones.

GENERAL DESCRIPTION

The TRPMs used shall conform to the following specifications:

Color Requirements

TRPM TYPE 3 is not required to meet these daytime color requirements. ALL TRPM Types shall appear the same color at night as the pavement markings they simulate or supplement.

All TRPM Types 1, 2, and 4 shall conform to the following requirements:

White TRPMs shall conform to color number 17778 of the Federal Standard Number 5952 for daytime visibility.

Yellow TRPMs shall conform to the Federal Highway Administration's (FHWA's) Yellow Color Tolerance Chart for daytime visibility.

A document certifying that the markers meet the above color standards shall be included with each shipment.

Number of Retroreflective Surfaces

All white TRPMs shall contain a one way reflector unless otherwise specified. This means that only one face of the marker contains a retroreflective surface. All yellow TRPMs shall contain a two way reflector unless otherwise specified. This means that both faces of the marker shall contain a retroreflective surface. If this is not possible, then two (2) markers installed back-to-back shall be used to provide two way reflectivity when needed as shown in the Plans or directed by the Engineer.

SPECIFICATIONS FOR EPOXY RESIN PAVEMENT MARKINGS (FREE OF TOXIC HEAVY METALS)**1.0 DESCRIPTION**

The work shall consist of furnishing and installing reflectorized white and yellow two-component, 100 percent solids epoxy pavement markings. Applications are lines, legends, symbols, crosswalks and stop lines placed on properly prepared asphaltic and portland cement concrete pavement surfaces in accordance with the Special Provisions, Plans, this Attachment and as directed by the Engineer. Upon curing, the materials produce pavement markings of specified thickness, width and retroreflectivity that resist wear from high traffic volumes for several years. During darkness and weather permitting, yellow markings shall be readily distinguishable from white markings.

Values stated in the International System of Units SI apply only to projects to be constructed in Metric units of measure. Values stated in inch-pound units (in parenthesis) apply only to projects to be constructed in English units of measure.

2.0 QUALIFICATIONS

- 2.1 Epoxy striping is a technical process requiring specialized equipment, quality controlled materials and well-trained operators to produce functional, long life pavement markings. To minimize application failures, MnDOT requires epoxy materials, beads, the pavement marking Contractor, and striper to be approved prior to the bidding process.
- 2.1.1 A pavement marking Contractor and/or equipment may be qualified as follows:
1. No previous epoxy striping on any construction contract-- contact MnDOT to arrange for field demonstration.
 2. Recent epoxy striping experience with other state transportation departments-- contact MnDOT and provide experience summary, including names of persons to be contacted.
 3. If striper is new, contact MnDOT to arrange for field demonstration.
- 2.1.2 Before any epoxy product is acceptable for bid, it shall be field tested, evaluated, approved and assigned a product identification number by the MnDOT Materials Engineering Section. An approved product is placed on the APPROVED PRODUCTS LIST which is shown in Section 2.1.4.
- 2.1.3 No change in product identification, chemical composition as indicated by infrared spectrophotometry and/or chemical analysis, or changes in the application requirements will be allowed. Any such changes shall be submitted for further evaluation.

**MnDOT EPOXY PAVEMENT MARKING MATERIAL
APPROVED PRODUCTS LIST**

2.1.4



Fast Dry (Type I)

<u>Manufacturer</u>	<u>Product</u>	<u>Appr Date</u>
Polycarb Inc.	MARK 55.3	1998
Epoplex	LS 50	1998

Slow Dry (Type II)

<u>Manufacturer</u>	<u>Product</u>	<u>Appr Date</u>
Polycarb Inc.	MARK 55	1991
Epoplex	LS 60	1998

3.0 MATERIAL CLASSIFICATIONS

- 3.1 This specification provides for the classification of epoxy resin pavement marking systems by type.
- 3.1.1 Type I - A fast cure material suitable for line applications and, under ideal conditions , may not require coning.
- 3.1.2 Type II - A slow cure material suitable for all applications of pavement markings under controlled traffic conditions, i.e., coning is required and flagging may be as directed by the Engineer.
- 3.1.2 **Only Slow Dry Type II epoxy material shall be used for epoxy pavement markings except when specified as otherwise in the Special Provisions.**

4.0 EPOXY AND BEAD REQUIREMENTS

- 4.1 Epoxy Resin Material
- 4.1.1 The material shall be composed of epoxy resins and pigments only. No solvents are to be given off to the environment upon application to a pavement surface.
- 4.1.2 The composition shall be within the tolerance permitted for the product tested and approved by MnDOT. Type II material shall be completely free of TMPTA (Tri-Methylol Propane Tri-Acrylate) and other multi-functional monomers.
- 4.1.3 **All materials shall be free of lead, cadmium, mercury, hexavalent chromium and other toxic heavy metals as defined by the United States Environmental Protection Agency.**
- 4.1.4 Color -- The color of the white epoxy shall be a pure flat white, free of tints. The color of the yellow epoxy shall closely match Color Number 33538 of Federal Standard 595 and shall conform to the following CIE Chromaticity limits using illuminant "C":

x | 0.470 | 0.485 | 0.520 | 0.480
y | 0.440 | 0.460 | 0.450 | 0.420

Daylight Directional Reflectance (Y), white, minimum 83
Daylight Directional Reflectance (Y), yellow, minimum 50

Testing will be according to :

Daylight Directional Reflectance

ASTM D 2805

Color

ASTM D 2805

- 4.1.5 Adhesion Capabilities -- When the adhesion of the material to portland cement concrete (the concrete shall have a minimum of 2,070 kPa (300 psi.) tensile strength) is tested according to American Concrete Institute Committee 403 testing procedure, the failure of the system must take place in the concrete. The concrete shall be 32°C when the material is applied, after which the material shall be allowed to cure for 72 hours at 23±2°C.
- 4.1.6 Abrasion Resistance -- When the abrasion resistance of the material is tested according to ASTM C 501 with a CS-17 wheel under a load of 1000 grams for 1000 cycles, the wear index shall be no greater than 82. (The wear index is the weight in milligrams that is abraded from the sample under the test conditions).
- 4.1.7 Hardness -- The Type D durometer hardness of the material shall be not less than 75 nor more than 90 when tested according to ASTM D2240 after the material has cured for 72 hours at 23±2°C.
- 4.1.8 Tensile Strength -- The tensile strength of the material, when tested according to ASTM D 638, shall not be less than 41,370 kPa (6,000 psi.) after 72 hours cure at 23±2°C.
- 4.1.9 Compressive Strength -- The compressive strength of the material, when tested according to ASTM D 695, shall not be less than 82,700 kPa (12,000 psi.) after 72 hours cure at 23±2°C.
- 4.1.10 Shelf Life -- The individual components shall not require mixing prior to use when stored for a period of 12 months.
- 4.2 Glass Beads
- 4.2.1 Glass beads shall meet the requirements of AASHTO M247, Type I, and:
- a. Coatings -- the beads shall be treated according to the manufacturers recommendations and meet the requirements of Section 4.4.2 of M247, and
 - b. Roundness-- the beads shall have a roundness of at least 80%.
- 4.2.2 For 380 µm (15 mil) applications, glass beads shall be applied at a rate of at least 3.0 kg/L (25 lb./gal.). **A greater bead application rate may be necessary for meeting the performance criteria (minimum levels of retroreflectivity). This will require Contractors to consult with all the material manufacturers.**
- 4.3 Time to No-Track -- Type I material shall be in "no-tracking" condition in 15 minutes or less and within 45 minutes for Type II material. The "no-tracking" condition shall be determined on an application of specified thickness to the pavement and covered with glass beads at the rate of at least 3.0 kg/L (25 lb./gal.). The lines for this test shall be applied with striping equipment operated so as to have the material at manufacturer's recommended application temperature. This maximum "no-tracking" time shall not be exceeded when the pavement temperature varies from 10 to 49°C (50 to 120°F) and under all humidity conditions, providing the pavement is dry. The no-tracking time shall be determined by passing over the line with a passenger car or pickup truck at a speed of 40 to 55 kmph (25 to 35 mph) in a simulated passing maneuver. A line showing no visual deposition of the material to the pavement surface when viewed from a distance of 15 m (50 ft.) shall be considered as showing "no-tracking" and conforming to this requirement for time to "no-track."



5.0 APPLICATION EQUIPMENT AND PROCEDURES

5.1 Equipment

- 5.1.1 Equipment furnished shall include an applicator truck of adequate size and power, designed to apply an epoxy resin material and glass beads in a continuous or intermittent line pattern. The equipment shall be capable of placing stripes on the left and right sides. The left carriage shall be capable of placing two lines simultaneously with either line in a solid or intermittent pattern in yellow or white. With change in color usage, an amount of material equal to fifteen 3 m (10 ft.) stripes shall be wasted to eliminate the change of the incorrect color being applied.
- 5.1.2 The applicator truck (striper) and other vehicles in the striping train shall have permanently mounted Type C flashing arrowboards. They shall be visible to oncoming or following traffic, depending on the type of line being placed. Arrowboard requirements are detailed in the "Field Manual" of the *Minnesota Manual of Traffic Control Devices*. Also, truck equipment shall be capable of accumulating the footage applied per gun, individually each day. Only material application shall activate the footage accumulators. The readout shall be digital and not adjustable.
- 5.1.3 The equipment shall be capable of applying glass beads in a pressurized system at a rate of at least 3.0 kg/L (25 lb./gal.). **A greater bead application rate may be necessary for meeting the performance criteria (minimum levels of retroreflectivity). This will require Contractors to consult with all the material manufacturers.**
- 5.1.4 All guns on the spray carriages shall be in full view of the operator(s) during operation.
- 5.1.5 Each crew shall include at least one technical expert knowledgeable in equipment operation, application techniques, control of traffic, and safety regulations.

5.2 Procedures

- 5.2.1 Pavement markings shall be placed in accordance with the details shown in the Plans and the control points established by the Engineer.
- 5.2.2 The road surface shall be cleaned at the direction of the Engineer just prior to an application. Pavement cleaning shall consist of at least brushing with a rotary broom (non-metallic), or as recommended by the material manufacturer and acceptable to the Engineer. New Portland cement concrete surfaces shall be sandblasted clean to remove any surface treatments and/or laitance. On low speed [Speed Limit 65 km/h (40 mph) or less] urban portland cement concrete roadways, sandblast cleaning shall be used for all epoxy pavement markings.
- 5.2.3 If the roadway surface is dry, the epoxy material application shall immediately follow the pavement cleaning and be preceded by an air blast. However, markings shall not be applied when the wind or other conditions cause a film of dust to be deposited on the pavement surface before the material can be applied.
- 5.2.4 The Engineer will place necessary spotting at appropriate points as overall horizontal control for striping and to indicate necessary starting and cutoff points. Broken line intervals will not be marked. Longitudinal joints, pavement edges, and existing markings shall serve as control points when so directed.
- 5.2.5 A 380 μ m (15 mil) epoxy line requires a liter of mixed components for every 25.8 m (84.5 ft.) of 100 mm (4 in.) wide line. Field measurements are inserted into the following equation: $\text{Line Thickness in micrometers} = \frac{\text{Liters} \times 0.001 \times 10^{-3} \times \text{m}^3}{\text{Length in meters} \times \text{width in meters}}$ (Thickness in inches = Gallons x 231 cubic inches divided by the quantity Length (inches) x Width (inches)). Use 3.785 liters per gallon if epoxy is metered in gallons.

- 5.2.6 The minimum line width shall be its nominal width with 6 mm (¼ in.) greater than the nominal width allowed provided the variation is gradual and does not detract from the general appearance. Broken line segments, normally 2 m (6.56 ft.) every 10 m (32.81 ft.), may vary up to 75 mm (3 in.) from the specified lengths provided the over and under variations are reasonably compensatory. Alignment deviations from the control guide shall not exceed , except when approved by the Engineer. Material shall not be applied over a longitudinal joint. Establishment of application tolerances shall not relieve the Contractor of his responsibility to comply as closely as practicable with the planned dimensions.
- 5.3 Spraying Operation
- 5.3.1 Placement of epoxy materials shall be permitted only on a clean, dry pavement surface and air and pavement temperatures at least 10° C (50° F) unless the manufacturer, in writing, approves a lower temperature.
- 5.3.2 Two parts of epoxy component A (pigment) and one part component B (hardener) shall be heated separately at 43±1° C (110±30° F) and thoroughly mixed. All material heated over 60° C (140° F) shall be discarded. The sprayed epoxy shall be applied at 43±1° C (110±30° F) **or as recommended by the manufacturer.**
- 5.3.3 Glass beads shall be applied immediately after the placement of the epoxy. If two bead gradations are required by the Special Provisions, two bead dispensers are required to deliver the specified drop rates. Otherwise the dispenser system must deliver at a minimum 3.0 kg (25 lb./gal.) of beads per liter of epoxy material. **A greater bead application rate may be necessary for meeting the performance criteria (minimum levels of retroreflectivity). This will require Contractors to consult with all the material manufacturers.**
- 5.3.4 The Contractor shall cooperate with inspection personnel in reviewing operation of the equipment, safety precautions, measurement of materials (components and beads), computations to determine specific and daily application rates, sampling materials, making other measurements, such as epoxy thickness, and notifications as to work schedule.
- 5.3.5 **Only Type II epoxy material shall be used for epoxy pavement markings except when specified as otherwise in the Special Provisions.**
- 5.3.6 Traffic control for the pavement marking operations shall be in substantial conformance with the "Field Manual," *Minnesota Manual of Uniform Traffic Control Devices* . **A shadow vehicle with a truck-mounted attenuator shall be used on high speed [SPEED LIMIT (65 km/h) (40 mph) and greater], high volume (ADT 1500 and greater) highways.**

6.0 SAMPLING RATE & PROCEDURES

- 6.1 One pint samples of each manufacturer's lot or batch furnished for the contract shall be **submitted to MnDOT at the time of manufacturing.** One pint samples of both Part A (yellow/white) & part B must be submitted to the MnDOT Materials Laboratory, 1400 Gervais Ave., Maplewood, Minnesota 55109. (612) 779-5550 or 5549, FAX: (612) 779-5616. Samples shall be identified as follows:

- | | |
|----------------------------------|------------------------------------|
| 1. Manufacturer's Name | 5. Color |
| 2. Manufacturer's Product Number | 6. Intended state project numbers. |
| 3. Lot/Batch Number | |
| 4. Date Manufactured | |



- 6.2 Contractors will not be allowed to use material that has not meet the requirements of Sections 6.1 & 7.0. Contractors will be asked to remove material that does not conform to Sections 6.1 & 7.0 and replace with material that does.

7.0 CERTIFICATIONS

- 7.1 The manufacturer shall certify that the components meet the requirements of these specifications and are on the MnDOT Approved Product List.
- 7.2 Certifications shall be sent along with the samples in section 6.1.

8.0 CONTAINER MARKINGS

- 8.1 Containers for epoxy components shall be marked with the manufacturer's name, product identification number, lot or batch number, date of manufacture, color, net weight of contents.
- 8.2 Containers for glass beads shall be marked with the name of manufacturer, the wording "Glass Beads," lot or batch number, coating type, date manufactured, and the net weight.

9.0 ACCEPTANCE OF PAVEMENT MARKINGS

In order to be a long-life pavement marking, epoxy markings placed in Minnesota must retain a satisfactory level of retroreflectivity in addition to demonstrating good adhesion, resisting chipping, and exhibiting proper daytime and nighttime colors. These attributes have been observed and evaluated for several years and are the basis for acceptance/rejection procedures and values used herein.

- 9.1 Retroreflectivity
- 9.1.1 Acceptable Minimum Retroreflectivity Values

MINIMUM AVERAGE RETROREFLECTIVITY VALUES FOR EPOXY MARKINGS (mcd/m²/lux)

<u>Period</u>	<u>White</u>	<u>Yellow</u>
Initial*	300	200
After-One-Winter*	175	140

* Described in Section 9.1.4 Miscellaneous Traffic Controls, Numbers 4 and 5.

- 9.1.2 Retroreflectometers-- Measurements shall be taken with either a portable or mobile retroreflectometer conforming to 30-meter geometry which is defined as: the entrance angle (the angle between the illumination axis and the retroreflector axis) shall fall between 88.50° and 88.76° and the observation angle (the angle between the illumination axis and the observation axis) shall fall between 1.0° and 1.05°; and, the co-viewing angle (the complement of the entrance angle) shall fall between 2.29° and 2.50°. All retroreflectivity readings and data analysis will be provided by MnDOT at no cost to the Contractor. MnDOT reserves the right to:

- make daytime and/or nighttime visual inspections with or without the presence of the Contractor's representative, mainly to locate obvious or suspect areas of deficiency, and

- ☐ determine retroreflectivity of symbols, legends and lines wider than 200 mm (8 in.) using the portable retroreflectometer only.

9.1.3 Test Segments -- The following methodology will be used to evaluate retroreflectivity performance of in-service longitudinal line pavement markings:

LENGTH AND NUMBER OF TEST SEGMENTS^a PER ROADWAY^b PER LINE TYPE^c

Length of Roadway	Number of Test Segments	Length of Test Segments
Less than 1.5 km (1 mi.)	1	300 m (0.2 mi.)
Greater than or equal to 1.5 km (1 mi.)	1 per 1.5 km (1 mi.)	300 m (0.2 mi.)

- ^a TEST SEGMENTS-- Areas of a roadway chosen for measuring retroreflectivity of the line types.
- ^b ROADWAY--As used here, means that portion of a street or highway ordinarily used for vehicular traffic. In the event a street or highway includes two or more separate roadways, the term roadway shall refer to each roadway separately.
- ^c LINE TYPE-- Longitudinal lines of the same color and function. For example, white and yellow edge lines are each a line type.

9.1.4 Measurements in Test Segments

Portable Retroreflectometer

1. Take a minimum of 20 readings in each test segment per line type.
2. On broken lines (skip striping), measure every other stripe, taking no more than two readings per stripe with readings 0.5 m (20 in.) from the ends of the marking.
3. For solid lines, divide test segment into ten areas of 30 m (100 ft.); space readings a minimum of 10 m (33 ft.) and a maximum of 30 m (100 ft.) apart.
4. For 10 percent of each message type, take 5 readings on each message line; for 10 percent of each symbol type, take 5 readings on each symbol.
5. Upon completion of the evaluation, regardless of the results, additional test segments may be ordered by the Engineer.

Mobile Retroreflectometer

1. Calibration of the instruments shall be in accordance with the manufacturer's instructions.
2. Retroreflectivity shall be measured at a minimum rate of 20 percent of each roadway length by line type.
3. Should another mobile unit be available, the maximum acceptable deviation for measurements made by the two different instruments of the same manufacturer and for the same roadway length shall be $\pm 10\%$.
4. Repeatability for the given mobile unit shall be $\pm 6\%$.
5. Upon completion of the evaluation, regardless of the results, additional test segments may be ordered by the Engineer.



Miscellaneous Controls

1. Take measurements on a clean, dry roadway.
2. Collect data in direction of traffic flow.
3. Measurement units are: mcd/m²/lux.
4. Wait at least two (2) weeks from date of placement of the markings before taking initial readings.
5. Take after-one-winter readings in May or June to assure that spring rains have cleaned the beads.
6. Randomly select test segments unless night reviews or other knowledge supersedes a random selection process.
7. Measure each line type separately.
8. The Engineer may request additional readings or test segments.
9. In the event LASERLUX is not available, the Engineer may require the use of the portable retroreflectometer or establish an alternative evaluation plan.

9.1.5 Contents of Retroreflectivity Report

The report shall consist of:

- ☐ State Project number
- ☐ Trunk Highway number
- ☐ Test date
- ☐ Geographical location of the test site(s), including distance from the nearest permanent site identification, such as a reference point.
- ☐ Identification of the pavement marking material tested: type, color, age, and transverse location on the road
- ☐ Identification of the retroreflectometer
- ☐ Remarks concerning the overall condition of the line, messages and symbols such as carryover of asphalt, snow plow damage, uneven distribution of beads, etc.
- ☐ Average of the readings for each test segment with one standard deviation calculated.
- ☐ Average of the readings for each message and symbol type.

9.2 Correction of Defects/Penalties

1. All pavement markings not conforming to the requirements of the Contract shall be removed and replaced or otherwise repaired to the satisfaction of the Engineer. Removal of unacceptable work shall be accomplished with suitable blasting or grinding equipment unless other means are authorized by the Engineer.
2. Where yield computations show a deficiency in material usage of not more than 20 percent, MnDOT may require satisfactory repair or may accept the work at a reduced unit price which is in direct proportion to the percent of the deficiency. Where the deficiency in material usage exceeds 20%, MnDOT may require removal and replacement to the satisfaction of the Engineer unless other means are approved by the Engineer.
3. If the Engineer requires removal and replacement, the Contractor shall remove (by an approved process) at least 90% of the deficient line, with no excessive scarring of the existing pavement. The removal width shall be one inch wider all around the nominal width of the pavement marking to be removed.

4. Where initial retroreflectivity falls below the minimum acceptable levels but not more than 20%, the Engineer may require satisfactory repair or may accept the work at a reduced unit price which is in direct proportion to the percent of the deficiency. Where the deficiency in retroreflectivity exceeds 20%, i.e., less than 240 mcd/m²/lux for white and 160 mcd/m²/lux for yellow, the Engineer may require the removal and replacement to the satisfaction of the Engineer unless other means are approved by the Engineer. Where minimum levels after one winter fall below the specified levels (170 mcd/m²/lux - 135 mcd/m²/lux), MnDOT will notify the project Contractor and manufacturer(s) of the failure. If the initial readings were above MnDOT's specified initial minimum levels (300 mcd/m²/lux - 200 mcd/m²/lux), the Engineer, Contractor, and manufacturer(s) of the material(s) shall review the project together. Based on the review an of all known aspects, the Engineer will make a determination as to why the job failed and notify the Contractor, pavement marking Contractor, and/or manufacturer(s) in writing.
5. If this process has to be repeated on several projects with either the same Contractor and/or manufacturer(s), MnDOT will take corrective action. This corrective action will be a two step process:

Step 1 Pavement marking Contractor/manufacturer(s) will be considered not approved for MnDOT projects, except to bring workmanship/product back into compliance.

Step 2 If the first step cannot be attained, pavement marking Contractor/manufacturer(s) will not be allowed to participate in MnDOT projects and/or be removed from Approved Product List.

10.0 DOCUMENTATION

Contractors applying epoxy pavement markings for MnDOT under a contract are required to fill out the attached "Construction Striping Report" form. These forms shall be completed at the end of each project. The original shall be given to the Engineer. Failure to submit completed forms may result in 10% of the overall contract price for epoxy pavement markings held back. The Engineer will fax them "ATTN: Pavement Marking Engineer" at 651-234-7370. If forms are not sent in to the reflective systems unit in a timely manner projects will not be inspected during optimum times for meeting their performance criteria. Any questions regarding this form can be answered by calling the Pavement Marking Engineer at (651) 234-7373. The form is on the website at: <http://www.dot.state.mn.us/trafficeng/products/ContractorStripingDailyReportForm.doc>



(1910) FUEL ESCALATION CLAUSE

January 28, 2009

The provisions set forth in MnDOT 1910 are hereby deleted, and the following is substituted therefore:

These provisions provide for compensation adjustments in the cost of motor fuels (diesel and gasoline) consumed in prosecuting the Contract work. The Engineer will calculate the Fuel Cost Adjustments. Payments or credits will be applied to partial and final payments for work items set forth herein.

For this purpose, the Department will establish a Base Fuel Index (BFI) for fuel to be used on the Project. The Base Fuel Index will be the average of the high and low rack prices shown for No. 2 ultra low sulfur fuel oil in the "OPIS Energy Group" tabulation titled "RackFax, Minneapolis, MN, OPIS Direct Gross No. 2 Distillate Fuels" for the day of the Contract letting.

A Current Fuel Index (CFI) in cents per gallon will be established for each month. The CFI will be the average of the high and low rack prices shown for No. 2 ultra low sulfur fuel oil in the "OPIS Energy Group" tabulation titled "RackFax, Minneapolis, MN, OPIS Direct Gross No. 2 Distillate Fuels" averaged for the beginning and ending dates of the monthly period being adjusted.

The Engineer will compute the ratio of the Current Fuel Index to the Base Fuel Index (CFI/BFI) each month. If that ratio falls between 0.85 and 1.15, no fuel adjustment will be made that month. If the ratio is less than 0.85, a credit to the Department will be computed. If the ratio is greater than 1.15, additional payment to the Contractor will be computed.

Credit or additional payment will be computed as follows:

- (1) The Engineer will estimate the quantity of work done in that month under each of the Contract items listed below.
- (2) The Engineer will compute the gallons of fuel used in that month for each of the Contract items listed below by applying the unit fuel usage factors shown.
- (3) The Engineer will summarize the total gallons (Q) of fuel used in that month for the applicable items.
- (4) The Engineer will determine the Fuel Cost Adjustment (FCA) from the following formulas:

If the Current Fuel Index (CFI) is greater than the Base Fuel Index (BFI), the following formula shall be used to determine the amount of Fuel Cost Adjustment to be paid to the Contractor. $FCA = [(CFI/BFI) - 1.15] \times Q \times BFI$

If the Current Fuel Index (CFI) is less than the Base Fuel Index (BFI), the following formula shall be used to determine the amount of Fuel Cost Adjustment to be credited to the Department.

$$FCA = [(CFI/BFI) - 0.85] \times Q \times BFI$$

Where FCA = Fuel Cost Adjustment (cents)

CFI = Current Fuel Index (cents per gallon)

BFI = Base Fuel Index (cents per gallon)

Q = Monthly total gallons of fuel

Basis of Payment

A Fuel Cost Adjustment payment to the Contractor will be made as a lump sum each payment period based on the last published CFI. A Fuel Cost Adjustment credit to the Department will be deducted as a lump sum each payment period from any monies due the Contractor. Upon completion of the work under the Contract, any difference between the estimated quantities previously paid and the final quantities will be determined. The CFI in effect on the day of completion of the Contract will be applied to the quantity differences in accordance with the procedures set forth above.

Schedule of Work Items

(Only items shown will be considered for compensation adjustments.)

ITEM		UNIT	GALLONS OF FUEL PER UNIT	UNIT	GALLONS OF FUEL PER UNIT
(1) Earthwork:					
2105.501	Common Excavation	Cu. Yd	0.17	m3	0.22
2105.503	Rock Excavation	Cu. Yd	0.27	m3	0.35
2105.505	Muck Excavation	Cu. Yd	0.17	m3	0.22
2105.507	Subgrade Excavation	Cu. Yd	0.17	m3	0.22
2105.515	Unclassified Excavation	Cu. Yd	0.23	m3	0.30
2105.521	Granular Borrow (EV)	Cu. Yd	0.17	m3	0.22
	Granular Borrow (CV)	Cu. Yd	0.19	m3	0.25
	Granular Borrow (LV)	Cu. Yd	0.14	m3	0.18
2105.522	Select Granular Borrow (EV)	Cu. Yd	0.17	m3	0.22
	Select Granular Borrow (CV)	Cu. Yd	0.19	m3	0.25
	Select Granular Borrow (LV)	Cu. Yd	0.14	m3	0.18
2105.523	Common Borrow (EV)	Cu. Yd	0.17	m3	0.22
	Common Borrow (CV)	Cu. Yd	0.19	m3	0.25
	Common Borrow (LV)	Cu. Yd	0.14	m3	0.18
2105.535	Topsoil Borrow (EV)	Cu. Yd	0.17	m3	0.22
	Topsoil Borrow (CV)	Cu. Yd	0.19	m3	0.25
	Topsoil Borrow (LV)	Cu. Yd	0.14	m3	0.18
2106.607	Common Embankment (CV)	Cu. Yd	0.19	m3	0.25
2106.607	Granular Embankment (CV)	Cu. Yd	0.19	m3	0.25
2106.607	Select Granular Embankment (CV)	Cu. Yd	0.19	m3	0.25
2106.607	Select Granular Embankment Modified (___ %) (CV)	Cu. Yd	0.19	m3	0.25
2106.607	Excavation – Rock	Cu. Yd	0.27	m3	0.35
2106.607	Excavation – Muck	Cu. Yd	0.17	m3	0.22



ITEM		UNIT	GALLONS OF FUEL PER UNIT	UNIT	GALLONS OF FUEL PER UNIT
(2) Aggregate Base:					
2211.501	Aggregate Base	Ton	0.55	t	0.61
2211.502	Aggregate Base (LV)	Cu. Yd	0.77	m3	1.01
2211.503	Aggregate Base (CV)	Cu. Yd	0.99	m3	1.29
2211.607	Open Graded Aggregate Base (CV)	Cu. Yd	0.99	m3	1.29
(3) Aggregate Shouldering:					
2221.501	Aggregate Shouldering	Ton	0.55	t	0.61
2221.502	Aggregate Shouldering (LV)	Cu. Yd	0.77	m3	1.01
2221.503	Aggregate Shouldering (CV)	Cu. Yd	0.99	m3	1.29
(4) Concrete Pavements:					
2301.511	Structural Concrete	Cu. Yd	0.98	m3	1.28
2301.513	Structural Concrete HE	Cu. Yd	0.98	m3	1.28
2301.604	Structural Concrete	Sq. Yd.	0.027*t	m2	0.00128*t
(5) Bituminous Pavements:					
2350.501	Type () Wearing Course Mixture ()	Ton	0.90	t	0.99
2350.502	Type () Non-Wearing Course Mixture ()	Ton	0.90	t	0.99
2350.503	Type () () Course (,) (t)" Thick	Sq. Yd	0.051*t		
2350.503	Type () () Course (,) (t) mm Thick			m2	0.0024*t
2360.501	Type SP () Wearing Course Mixture ()	Ton	0.90	t	0.99
2360.502	Type SP () Non-Wearing Course Mixture (,)	Ton	0.90	t	0.99
2360.503	Type SP () () Course (,) (t)" thick	Sq. Yd	0.051*t		
2360.503	Type SP () () Course (,) (t) mm thick			m2	0.0024*t
(6) Pipe:***:					
2501.511	— Pipe Culvert —	Lin. Ft.	0.70	m	2.30
2501.521	— Pipe Arch Culvert —	Lin. Ft.	0.70	m	2.30
2501.561	— Pipe Culvert Des 3006 —	Lin. Ft.	0.70	m	2.30
2501.603	— Pipe Culvert —	Lin. Ft.	0.70	m	2.30
2503.511	— Pipe Sewer —	Lin. Ft.	0.70	m	2.30
2503.521	— Pipe Arch Sewer —	Lin. Ft.	0.70	m	2.30
2503.541	— Pipe Sewer Des 3006 —	Lin. Ft.	0.70	m	2.30
2503.603	— Pipe Sewer —	Lin. Ft.	0.70	m	2.30

t = thickness

NOTE: No price No price adjustments will be made on fuel used for drying and heating aggregates.

*** No price adjustment will be made for pipes less than 12" in diameter or jacked pipes.

SCHEDULE OF MATERIALS CONTROL

See also website <http://www.dot.state.mn.us/materials/labmcs.html> for March 15, 2013.

66 sheets

Minnesota Department of Transportation Schedule of Materials Control (SMC) – Introduction Page
(Federal Aid, State Funds, County/Municipal Federal Aid Projects and State Aid Projects)

This schedule outlines the minimum sampling and testing required for most materials used in highway construction. Some items that are rarely used or materials of recent development are often covered by special provisions and may not be shown on the schedule. For more information regarding contract requirements for testing, please reference the "Standard Specifications for Construction", Specification 1603 Materials: Specifications, Samples, Tests, and Acceptance.

Laboratories performing acceptance tests for payment shall be accredited by the AASHTO Materials Reference Laboratory (AMRL) or a comparable accreditation program approved by MnDOT and the FHWA for all test procedures performed. Grading and Base materials are exempt from the accreditation requirement.

When sample sizes required for testing exceed 35 pounds, please submit multiple containers of the material with no individual container weighing more than 35 pounds.

Small quantities of materials may be accepted without sampling and testing. A small quantity is defined as any total quantity, for the whole project, of one material, which is smaller than the minimum quantity required for testing unless modified by the individual material items. These materials shall be from known, reliable sources, perform satisfactorily and meet the requirements for purpose intended. The inspection report (Form 02415) should include a statement to this effect and show the source. Form 2403 may be used to report small quantities of diverse materials from different sources. Form 02415 and Form 2403 (or approved revisions) are referenced in the Schedule of Materials Control for project record documentation and are required to be maintained in the project file.

Previously approved materials transferred from another project should be reported on Form 02415. The report should include: type of material, quantities involved, source, and supplier of materials. Whenever possible, include the project number for which the material was originally approved.

If Forms 02415 and 2403 are referenced by form number within the Materials Control Schedule for materials or products received from pre-approved sources, where the field responsibility for acceptance is visual inspection and all information required to complete these forms is contained in other documents in the project file, the use of these forms becomes optional. If these forms are completed and sent to the Project Engineer by off-site inspection personnel from the district or the Office of Materials, they must be retained in the project file.

A Telephone Index is included with the Schedule giving contact information for the specialty areas if further information is required regarding the various materials. A form index is also included.

The Department maintains the Approved/Qualified Products List and the Certified Products and Services List, as well as, the Schedule of Materials Control. All are available electronically on the Office of Materials and Road Research website. www.dot.state.mn.us/materials.html

Products manufactured offsite may be pre-approved; however, final acceptance will be made at the point of incorporation, based upon review of documentation and inspection for shipping or other damage.

Contact the MnDOT District Independent Assurance Inspector when project starts to provide the proper servicing of your project.

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IX. Geosynthetics, Pipe, Tile, and Precast/Prestressed Concrete	58 thru 62
X. Brick, Stone, and Masonry Units	63
XI. Electrical and Signal Construction Items	64 thru 66

Certifications List

Material	SMC Section	Sub Section	Page	Certification Needed
All Base, Surface, and Granular Materials	I. Grading & Base	Many	7-13	Form G&B-104 (24346) include gradation, crushing, bitumen content, and quality test results
Plant Mixed Asphalt (PMA)	II. Bituminous	Many	14-20	All PMA from certified supplier www.dot.state.mn.us/materials/bituminous.html
Shingles	II. Bituminous		15	Contractor shall provide documentation that of all RAS /TOSS (Tear Off Shingle) material is from a MPCA certified supplier.
Bituminous Material	II. Bituminous		19	Only Bituminous Materials from certified asphalt binder sources are allowed for use. The most current list of Certified Sources can at http://www.dot.state.mn.us/products
Emulsified Asphalt	II. Bituminous		19	Use Emulsion for seal coat from a certified emulsified asphalt source.
Certified Ready Mix	IV. Concrete	Many	28-29	Contact Report from Ready-Mix Plant. All concrete from certified plant including a computerized certificate of compliance with each load.
Portland Cement Fly Ash Ground Granulated Blast Furnace Slag Cement Admixtures	IV. Concrete		27	Concrete Plant Batching Materials: All materials must come from certified approved, or qualified sources. All certified sources must state so on the Bill of Lading Delivery invoice including MnDOT standardized certification statement for cement, flyash, and slag. The most current list of certified/approved sources can be found at www.dot.state.mn.us/products .
Plastic for Curing	IV. Concrete		35	A Certificate of Compliance shall be submitted to the Project Engineer from the Manufacturer certifying that the plastic complies with AASHTO M171.
Aggregate for Low Slump Overlays	IV. Concrete		39	Aggregate pit numbers and 1 passing gradation result per fraction per source

Certifications List (cont.)

Material	SMC Section	Sub Section	Page	Certification Needed
Profiler	IV. Concrete		38	Contractor provides MnDOT certified Inertial Profiler Results for bumps/dips and/or Areas of Localized Roughness for the entire project.
Aggregate for Concrete Pavement Repair	IV. Concrete		40	Aggregate pit numbers and 1 passing gradation result per fraction per source
Aggregate for Dowel Bar Retrofits	IV. Concrete		42	Aggregate pit numbers and 1 passing gradation result per fraction per source
Plant Stock & Landscape Materials	V: Landscaping etc.	2	43	Several certifications
Silt Fence	V: Landscaping etc.	5	44	Certificate of Compliance with MARV values
Flotation Silt Curtain	V: Landscaping etc.	6	44	Manufacturers' certification of compliance
Mulch Type 3	V: Landscaping etc.	12	44	Certified Vendor by Minnesota Crop Improvement Association must be tagged grain straw only on label.
Mulch Type 6 Wood Chips	V: Landscaping etc.	13	45	Emerald Ash Borer Compliance Agreement with the MDA
Seeds	V: Landscaping etc.	14	45	Certified Vendor by Minnesota Crop Improvement Association must be tagged.
Seeds - Native	V: Landscaping etc.	14	45	Certified Vendor by Minnesota Crop Improvement Association must be tagged.
Sod	V: Landscaping etc.	15	45	A certified tag by Minnesota Crop Improvement Association for Salt tolerant sod. A certificate of Compliance for all other types of sod listing grass varieties.
Compost	V: Landscaping etc.	16	45	A/QPL with certified test reports.
Waterproofing material membrane waterproof system	VI: Chemical Items		46	Certificate and test results
Waterborne latex traffic marking paint	VI: Chemical Items		47	Certificate of Compliance
Epoxy traffic paint	VI: Chemical Items		47	Certificate of Compliance
Traffic marking paint	VI: Chemical Items		47	Certificate of Compliance
Non-traffic marking paint	VI: Chemical Items		47	Certificate of Compliance
Bridge structural steel paint	VI: Chemical Items		48	Certificate of Compliance
Exterior masonry paint	VI: Chemical Items		48	Certificate of Compliance
Noise wall stain	VI: Chemical Items		48	Certificate of Compliance
Drop-on glass beads	VI: Chemical Items		48	Certificate of Compliance
Pavement marking tape	VI: Chemical Items		48	Certificate of Compliance
Steel sign posts	VII: Metallic	2	50	Certification of domestic source if applicable under 1601
Posts for traffic or fence	VII: Metallic	3A	50	Certification of domestic source if applicable under 1601 For fence: Fence certification form (Optional)
Fence components	VII: Metallic	3B	50	Fence certification form (Optional)
Fence gates	VII: Metallic	3C	50	Fence certification form (Optional)
Fence barbed wire fabric	VII: Metallic	3D	50	Fence certification form (Optional)
Fence woven wire fabric	VII: Metallic	3E	51	Fence certification form (Optional)
Fence chain link wire fabric	VII: Metallic	3F	51	Fence certification form (Optional)
Reinforcing steel uncoated bars	VII: Metallic	5A	51	Certificate of Compliance & certified mill analysis
Reinforcing steel epoxy bars	VII: Metallic	5B	52	Inspected tag or Certificate of Compliance & certified mill analysis
Steel Fabric	VII: Metallic	5E	52	Certificate of Compliance

Certifications List (cont.)

Material	SMC Section	Sub Section	Page	Certification Needed
Dowel Bars	VII: Metallic	5F	52	Certificate of Compliance
Pre or post tensioning strand	VII: Metallic	5G	53	Mill analysis
Anchor rods & Structural Fasteners	VII: Metallic	7, 8	53	Yearly MnDOT passing test report
Timber & lumber	VIII: Miscellaneous	1	57	Certified on invoice
Bearing pads	VIII: Miscellaneous	4	57	Certificate of Compliance
Corrugated metal pipe	IX: Geosynthetics & Pipe	1A	58	Certified on invoice
Corrugated metal structural plate	IX: Geosynthetics & Pipe	1B	58	Certified on invoice
Corrugated metal aluminum plate	IX: Geosynthetics & Pipe	1C	58	Fabricator's Certificate and guarantee
Concrete pipe & manholes reinforced	IX: Geosynthetics & Pipe	3A	58	Certified stamp and certification document
Precast box culverts	IX: Geosynthetics & Pipe	4A	59	Stamped & field inspection report
Prestressed beams & posts, etc	IX: Geosynthetics & Pipe	4B	59	Stamped & field inspection report
Manholes & catch basins	IX: Geosynthetics & Pipe	5	60	Certification document or stamped
Thermoplastic pipe ABS & PVC	IX: Geosynthetics & Pipe	7	60	Certificate of Compliance
Corrugated PE Pipe: Single wall – edge drains	IX: Geosynthetics & Pipe	8	60	Certificate of Compliance
Corrugated PE Pipe: dual wall – 12"-48"	IX: Geosynthetics & Pipe	13	61	Certificate of Compliance
Geotextile fabric	IX: Geosynthetics & Pipe	14	62	Manufacturers' Certification of compliance
Brick sewer concrete	X: Brick, Stone, Masonry	1B	63	Air content statement
Concrete masonry units	X: Brick, Stone, Masonry	2A	63	Air content statement
Light standards	XI: Electrical & Signal	1	64	Certificate of Compliance
Cable & Conductors	XI: Electrical & Signal	7	65	Usually inspected at the distributor. Documentation showing project number, reel number(s), & MnDOT test number(s) will be included with each project shipment. If not received from Contractor, submit sample for testing along with manufacturers' material certification.
Electrical systems	XI: Electrical & Signal	10	66	Electrical Systems are to be reported as a "System" using the Lighting, Signal, and Traffic Recorder Inspection Report.
Traffic signal systems	XI: Electrical & Signal	11	66	Traffic Signal Systems are to be reported as a "System" using the Lighting, Signal, and Traffic Recorder Inspection Report.

Telephone Index for Schedule of Materials Control

Section	Page	Section Name	Contact	Phone
Part I	Page 7	Grading & Base – Specifications 2105, 2106, 2118, 2211, 2212, 2215, and 2221	Terry Beaudry Cary Efta Rebecca Embacher	(651) 366-5456 (651) 366-5421 (651) 366-5525
Website: www.dot.state.mn.us/materials/gradingandbase.html				
Part II	Page 14	Bituminous - Spec. 2360	John Garrity	(651) 366-5577
Part II C	Page 19	Asphalt Binder	Jim McGraw Jason Szondy	(651) 366-5548 (651) 366-5549
Website: www.dot.state.mn.us/materials/bituminous.html				
Part III	Page 21	Bituminous Specialty Items	Terry Beaudry Greg Schneider Tom Wood	(651) 366-5456 (651) 366-5403 (651) 366-5573
Part IV	Page 26	Concrete – Aggregates and Mix Design Concrete – Certified Ready Mix Concrete Concrete Paving Concrete – Bridges Concrete – Pavement Rehabilitation	Wendy Garr Wendy Garr Rob Golish Ron Mulvaney Gordy Bruhn	(651) 366-5423 (651) 366-5423 (651) 366-5576 (651) 366-5575 (651) 366-5523
Website: www.dot.state.mn.us/materials/concrete.html				
Part V	Page 43	Landscaping and Erosion Control Items Erosion Control Landscaping Wood Chips	Lori Belz Scott Bradley Tina Markeson	(651) 366-3607 (651) 366-4612 (651) 366-3619
Part VI	Page 46	Chemical Items	Jim McGraw Dave Iverson	(651) 366-5548 (651) 366-5550
Part VII	Page 49	Metallic Materials and Metal Products Sampling Test Results Bridge Structural Metals	Steve Grover Laboratory Todd Niemann Barry Glassman	(651) 366-5540 (651) 366-5560 (651) 366-4567 (651) 366-4568
Part VIII	Page 57	Miscellaneous Materials Sections 1 thru 3 Section 4 Test Results	Steve Grover Todd Niemann Barry Glassman Laboratory	(651) 366-5540 (651) 366-4567 (651) 366-4568 (651) 366-5560
Part IX	Page 58	Geosynthetics, Pipe, Tile, and Precast/Prestressed Concrete Sections 1 thru 11, & 13 Section 12 Section 14 Test Results	Steve Grover Rich Lamb Randy Tilseth Laboratory	(651) 366-5540 (651) 366-5595 (651) 366-5451 (651) 366-5560
Part X	Page 63	Brick, Stone and Masonry Units/Modular Retaining Wall Blocks Sections 1, 2A, 3, & 4 Section 2B Test Results	Steve Grover Blake Nelson Laboratory	(651) 366-5540 (651) 366-5599 (651) 366-5561
Part XI	Page 64	Electrical & Signal Sections 1, 8-11 Section 2, 4- 7 Section 3 Test Results	Susan Zarling Steve Grover Wendy Garr Laboratory	(651) 234-7052 (651) 366-5540 (651) 366-5423 (651) 366-5560

Form Index

Grading and Base	
Form No.	Form Name
G&B – 001 (02115-03)	Grading & Base Report
G&B – 002 (02154-02)	Random Sampling Acceptance
G&B – 101 (02402-03)	Sieve Analysis
G&B – 103 (02463)	Percent Crushing Report
G&B – 104 (24346)	Certificate of Aggregates & Granular Materials
G&B – 105 (21850)	Moisture Test
G&B – 203	(Table 2105-6, 2106-6) DCP Penetration Index Method
G&B – 204	(Table 2211-3) DCP Penetration Index Method
G&B – 205	2215 DCP Penetration Index Form – Full Depth Reclamation
G&B – 303 (24587-01)	Moisture - Density (Proctor) Test
G&B – 304 (02140-03)	Relative Density Test
Concrete	
Form No.	Form Name
2152	Concrete Batching Report
2162	Concrete Test Beam Data
2409	ID Card Concrete Test Cylinder
2448	Weekly Concrete Report
2449	Weekly Concrete Aggregate Report (QC/QA)
21412	Weekly Report of “Low Slump Concrete”
21763	Concrete Aggregate Worksheet
21764	Concrete Aggregate Worksheet JMF - Paving
21765	Concrete Aggregate Worksheet JMF
24143	Weekly Certified Ready-Mix Plant Report (Verification)
24300	ID Card Cement Samples
24308	ID Card Fly Ash Samples
24327	Field Core Report
	Concrete W/C Ratio Calculation Worksheet
	Incentive/Disincentive Smoothness Worksheet
Bituminous	
Form No.	Form Name
2413	Asphalt Sample Identification Card
Miscellaneous	
Form No.	Form Name
2410	Sample ID Card
02415	Inspection Report on (May be used for documentation or use another method to capture required documentation)
2403	Inspection Report for Small Quantities (May be used for documentation or use another method to capture required documentation)
	Certification Form for Type of Fence used, see on right side of page, www.dot.state.mn.us/materials/lab.html

I. Grading and Base Construction Items 2005 and 2013 Spec Book (www.dot.state.mn.us/materials/gradingandbase.html)

Pay Item Number	Material	Spec. No.	Minimum Contractor Quality Control Testing Rate	Minimum Agency Verification (Acceptance) Testing (See Note 1)		Minimum Companion (Split Lab) Sample (See Notes 2 & 3)		Form No. (See Note 5)
				Rate	Size	Rate	Size	
(a) 2118 (b) 2211 (c) 2221 or 2118 (d) Spec. Prov. or 2212	1. Gradation (a) Aggregate Surfacing (b) Aggregate Base (c) Aggregate Shoulders (d) Drainable Aggregate Base (OGAB & DSB)	3136, 3138, & Special Provisions	Production: 1/550 yd ³ (CV)	<p>Random Sampling</p> <ul style="list-style-type: none"> • < 280 yd³ (CV) No tests Required • ≥ 280 yd³ (CV) to < 1,100 yd³ (CV) <ol style="list-style-type: none"> 1. Lot Size = Total Quantity 2. Divide lot into two equal sublots 3. Collect one random sample from each subplot 4. Average results to determine compliance • ≥ 1,100 yd³ (CV) to < 5,500 yd³ (CV) <ol style="list-style-type: none"> 1. Lot Size = Total Quantity 2. Divide Lot into four equal sublots 3. Collect one random sample from each subplot. 4. Average results to determine compliance • ≥ 5,500 yd³ (CV) <ol style="list-style-type: none"> 1. 	60 lb	1 per project in this category. Obtain split sample from the 1 st verification sample.	30 lb.	G&B-001 (02115-03) G&B-002 (02154-02) G&B-101 (02402) G&B-104 (24346-02)

I. Grading and Base Construction Items 2005 and 2013 Spec Book (www.dot.state.mn.us/materials/gradingandbase.html)

Pay Item Number	Material	Spec. No.	Minimum Contractor Quality Control Testing Rate	Minimum Agency Verification (Acceptance) Testing (See note 1)		Minimum Companion (Split Lab) Sample (See Notes 2 & 3)		Form No. (See Note 5)
				Rate	Size	Rate	Size	
(e) 2105 2106	1. Gradation(Continued) (e) Granular Borrow Select Granular Borrow Modified Granular Borrow Stabilizing Aggregate	3149 & Special Provisions	1/10,000 yd ³ (CV)	1/20,000 yd ³ (CV)	30 lb.	1 per project in this category. Obtain split sample from the 1 st verification sample	30 lb.	G&B-001 (02115-03), G&B-101 (02402-03) G&B-104 (24346-02)
(f) Special Provisions & 2215	(f) Full Depth Reclamation (FDR)	Special Provisions & 3135	1/6,000 yd ² (See Note 10)	1/12,000 yd ²	60 lb	NA	NA	G&B-001 (02115-03) G&B-101 (02402-03)
(g) 2511	(g) Granular Filter	3601 & Special Provisions	1 per source before delivery on project	1 per source	300 lb	NA	NA	G&B-001 (02115-03) G&B-101 (02402-03) G&B-104 (24346-02)
(h) 2451 (i) 2451 (j) 2451 (k) 2451 (l) 2451 (m) 2502	(h) Granular Backfill (i) Aggregate Backfill (j) Granular Bedding (k) Aggregate Bedding (l) Coarse Filter Aggregate (m) Fine Filter Aggregate	3149 & Special Provisions	Two per source before delivery on project	1 per source	60 lb	NA	NA	G&B-001 (02115-03) G&B-101 (02402-03) G&B-104 (24346-02)

I. Grading and Base Construction Items 2005 and 2013 Spec Book (www.dot.state.mn.us/materials/gradingandbase.html)

Pay Item Number	Material	Spec. No.	Minimum Contractor Quality Control Testing Rate	Minimum Agency Verification (Acceptance) Testing (See Note 1)		Minimum Companion (Split Lab) Sample (See Notes 2 & 3)		Form No. (See Note 5)
				Rate	Size	Rate	Size	
(a) 2211 (b) 2221 (c) 2105 2106	2. Proctor Test (a) Aggregate Base (b) Aggregate Shoulder	2211, 2221, & Special Provisions		(See Note 8) 2005 Spec Book: 1 per source 2013 Spec Book 1 per source		1 per project in this category. Obtain split sample from the 1 st verification sample	25 lb.	G&B-303 (24587-01)
	(c) Embankment Soil, Granular Borrow, Select Granular Borrow, & Modified Granular Borrow	2105 & 2106	2005 Spec Book: 2013 Spec Book: 1 major soil type (See Notes 7 & 11)	2005 & 2013 Spec Book : For Specified Density: 1/major soil type. 2013 Spec Book: For all other compaction requirements: One Contractor Companion/project	50 lbs.			
(a) 2211 (b) 2221	3. Specified Density Test (Sand Cone or other) (a) Aggregate Base (b) Aggregate Shoulder	2211, 2221 & Special Provisions		(See Note 8) 1/1,000 yd ³ (CV)		NA	NA	G&B-001 (02115-03)
	(c) 2105 2106	(c) Embankment Soil, Granular Borrow, Select Granular Borrow & Modified Granular Borrow	2105, 2106 & Special Provisions		1/4,000 yd ³ (CV)			G&B-304 (02140-03)

I. Grading and Base Construction Items 2005 and 2013 Spec Book (www.dot.state.mn.us/materials/gradingandbase.html)

Pay Item Number	Material	Spec. No.	Minimum Contractor Quality Control Testing Rate	Minimum Agency Verification (Acceptance) Testing Rate (See Note 1)	Form No. (See Note 5)
(a) 2211 (b) 2221 (c) 2215	4. Dynamic Cone Penetration (DCP) Index (a) Aggregate Base (b) Aggregate Shoulder (c) Full Depth Reclamation (FDR)	2211, 2221, & Special Provisions		1 DCP test/500 yd ³ (CV)	G&B-001 (02115-03) G&B-204 (02170-02)
		3135 & Special Provisions			
		2105, 2106, 3149 & Special Provisions			
(d) 2105 2106	(d) Granular Borrow Select Granular Borrow & Modified Granular Borrow and all other granular materials.			Roadway Embankment: One DCP test/2,000 yd ³ (CV). Structure Trenches: One DCP test/2,000 yd ³ (CV), with a minimum of one DCP test per 250 feet of each structure length. Test entire layer.	G&B-001 (02115-03) G&B-203 (02170-02)
(a) 2118 (b) 2211 (c) 2212 (d) 2221	5. Moisture Content Test During Compaction (See Note 9) (a) Aggregate Surfacing (b) Aggregate Base (c) Drainable Aggregate Base (d) Shoulder Base Aggregate	2211, 2221, & Special Provisions	2005 Spec Book — 2013 Spec Book 1/1,000 yd ³	2005 Spec book: 1/1,000 yd ³ or 10 tests whichever is less 2013 Spec Book: One Contractor Companion/project	G&B-001 (02115-03) G&B-105 (21850-02)
(e) 2215	(e) Full Depth Reclamation (See Note 9)	2215 or Special Provisions	2005 Spec Book — 2013 Spec Book 1/6,000 yd ²	2005 Spec book: 1/6,000 yd ² 2013 Spec Book: —	
(f) 2105 2106	(f) All embankment materials (See Note 9)	2105, 2106 & Special Provisions	2005 Spec Book — 2013 Spec Book 1/10,000 yd ³	2005 Spec Book 1/10,000 yd ³ 2013 Spec Book One Contractor Companion/project	

I. Grading and Base Construction Items 2005 and 2013 Spec Book (www.dot.state.mn.us/materials/gradingandbase.html)

Pay Item Number	Material	Spec. No.	Minimum Contractor Quality Control Testing Rate	Minimum Agency Verification (Acceptance) Testing (See Note 4)		Form No. (See Note 5)
				Rate	Size	
2105 2106 2118 2211 2212 2221	6. Percent Crushing	3136, 3138, 3149 & Special Provisions	1/Day	2 per source	30 lb.	G&B-103 (02463) G&B-104 (24346-02)
2105 2106 2118 2206 2211 2212 2221 2451 2502	7. Aggregate Quality (LAR, Insoluble Residue, Lithological Exam & Bitumen Content)		1/source (See Note 6)			
2215	8. Depth Check Full Depth Reclamation (FDR)		1/1000 feet			G&B-104 (24346-02)
			1/1000 feet			
			1/3000 feet			

I. Grading and Base Construction Items 2005 and 2013 Spec Book (www.dot.state.mn.us/materials/gradingandbase.html)

General Notes: Sampling and Testing Procedures are found in the Grading and Base Manual in Section 5-692.200. Obtain all gradation, quality and crushing samples after spreading and before compaction.

Modify testing and sampling protocol for increases in Plan quantities as follows:

Time Plan Quantity Increased	Testing and Sampling
Before Collection of first sample.	Reorder sampling to account for additional quantity.
After Collection of first sample, but before sampling is complete.	Complete testing of current lot, and then reorder the sampling using the remaining quantity.
After collection of all original Plan quantity samples.	Order sampling for additional quantity.

I. Grading and Base Construction Items 2005 and 2013 Spec Book (www.dot.state.mn.us/materials/gradingandbase.html)

Note 1: Verification gradation samples are not required for 280 yd³ (CV) (500 tons) or less. Report small quantities on Form 02415 or 2403. <http://www.dot.state.mn.us/const/tools/forms.html>.

Note 2: Perform Companion testing using different equipment and personnel from the Verification sample. Obtain the Companion sample as a split sample from the first Agency Verification sample, and include the gradation results on the sample card. Laboratories with AMRL accreditation that are performing the Agency Verification testing are not required to submit companion samples.

Note 3: Companion gradation and proctor, and Verification crushing and aggregate quality samples are not required for 550 yd³ (CV) (1,000 tons) or less.

Note 4:

- Carbonate aggregates require 50 lb. samples for lab testing.
- Submit the initial aggregate quality and crushing sample from the first day's production.
- The crushing test will not be required when the material is crushed from a quarry.
- A second test is required, when the first test fails. Average both tests to determined compliance, when two tests are performed.
- Not all quality and crushing tests are required for each material, see specifications
- Use the table below as a **guideline**, **determination of specific required tests is through the Specifications and/or the Special Provisions.**

Note 5: Tests may be reported on Grading and Base forms or on MnDOT LIMs Reports. Forms are available on the Grading & Base website at: <http://www.dot.state.mn.us/materials/gradingandbase.html>

Note 6: Use the Centrifuge Method (MnDOT Lab. Manual Method 1852) to determine bitumen content.

Note 7: Major soil types are defined in the Triaxial Chart located in the Grading and Base Manual.

Note 8: Required only for specified density.

Note 9: Required during Compaction. For Quality Compaction of Shoulder Surfacing Aggregate (2118 or 2221), the Engineer may replace the moisture testing requirement with time stamped photo documentation of water being applied.

Note 10: Provide gradation test results to the Engineer within the first 500 feet (150 m) of production and within 500 feet (150 m) after a failing gradation.

Note 11: The Contractor may use a one point Proctor, or the estimated optimum moisture content formula (Form G&B- 305) to determine the optimum moisture.

I. Grading and Base Construction Items 2005 and 2013 Spec Book (www.dot.state.mn.us/materials/gradingandbase.html)

Table: Guidelines for Required Crushing and Aggregate Quality Tests				
Material	Crushing	Bitumen Content	LAR	Lithological Exam & Shale Float Test
3136 Drainable Bases	Yes.	Not applicable	Yes	Yes, when not from quarried source.
3138 Aggregate for Surface and Base	Not required for quarried sources. Yes for Class 5, 5Q and 6. Test waived if material contains recycled at twice the minimum crushing requirement.	Yes, if it contains Bitumen.	Yes, if source is carbonate quarry and does not contain bitumen.	Yes for Class 3, 4, 5, 5Q and 6, when not from quarried rock, and does not contain bitumen.
3149 Granular Material *	Not required for quarried sources. Yes for Stabilizing Aggregate, Fine Aggregate Bedding and Medium Filter Aggregate. Test waived if material contains recycled at twice the minimum crushing requirement.	Yes, if it contains Bitumen	Not applicable	Yes for Medium Filter Aggregate
* Note for 3149.2D.2 Granular Materials - Structural Backfill, perform all tests required of 3137.2B3, shear angle test (AASHTO T236) and Proctor.				

Grading and Base Conversion from Volume (CV) to Weight

If possible, always perform a proctor for the material in question to obtain a conversion factor.

Only use the following conversion factor for materials meeting specifications 3138 or 3149 Stabilizing Aggregate. Material may be composed of crushed limestone, granite, gneiss, quartzite, recycled materials or natural gravel. **Do not** use the conversion factor for crushed basalt, taconite, or other heavy or light-weight aggregates. For other materials or gradations contact the Grading and Base Unit.

To convert from volume to weight use the following: **1 yd³ (CV) = 1.8 tons.**

See the Grading and Base Manual section .430 for further explanation.

II. Bituminous Construction Items for Specification 2360

Note: Projects with bituminous tonnage less than or equal to 300 tons (272 metric tons) per day may be accepted on a small quantity basis at the discretion of the Engineer. Retain Form 02415 or Form 2403 in Project File.

(All plant mixed asphalt from Certified Plants)

DEFINITIONS

SAMPLE TYPE	DESCRIPTION	SAMPLE LOCATION DETERMINED BY	SAMPLE TAKEN BY	SAMPLE TESTED BY
QC	Quality Control Testing performed by Contractor. Also known as Process Control Testing.	Contractor	Contractor	Contractor
QA	Quality Assurance Testing performed by the Agency. This test is performed on a companion sample to the Contractor's QC sample.	Contractor Contractor (mixture) Agency (density cores)	Contractor	Agency
Verification	A sample to assure compliance of the Contractor's Quality Control program. The results shall be included as part of the QA Testing Program.	Agency	Agency	Agency
Verification Companion	A companion sample to the Agency's Verification sample provided to the Contractor. The Contractor is required to test this sample. The results shall be used as part of the QC program.	Agency	Agency	Contractor
IAST	The Independent Assurance Sampling and Testing assures testers are sampling and testing properly and that equipment is calibrated correctly.	Agency	Contractor or Agency	Contractor or Agency

A. Pre-Production Sampling and Testing for Specification 2360 Plant Mixed Asphalt**Minimum Sample Sizes:****Quality Sample Size for Lab Submittal:**

Plus #4 aggregate sample for quality testing and Percent Crushing 80 lb. (35 kg)
 Minus #4 aggregate for quality testing 35 lb. (15 kg)
 Bituminous mixture plus 2 Gyratory specimens for volumetric testing 80 lb. (35 kg)
 Bituminous mixture for TSR testing (option A) 80 lb. (35 kg)
 Bituminous mixture for TSR testing plus 6 Gyratory specimens (option B) 20 lb. (10 kg)
 Mineral filler. 2 lb (1 kg)
 RAP for Quality Testing 80 lb (35 kg)
 RAS (shingles) for Gradation and Quality Testing 10 lb (5 kg)
 Asphalt Binder 1 qt (1L)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2360	Bituminous Mix Design (QC/QA)	2360	Contractor submits Mix Design Option 1 or Option 2	Option 1- Laboratory Mix Design: In addition to reviewing the Trial Mix data (JMF), test Contractor's mixture (at optimum asphalt content). Also, evaluate TSR per 2360.2E5a(3). Option 2- Laboratory Mix Design: Review submitted Mix data only.	Approved Mix Design Report
2360	Aggregate Quality Testing (QA only)	2360	Provide 24 hour notice of intent to sample aggregates for quality testing. Agency has the option to monitor sampling. Submits to the Bituminous Engineer or the District Materials Engineer one (1) sample of each non-asphaltic aggregate type or class per source per year. Also submit the asphaltic aggregate material when the mixture contains RAP or RAS. Provide documentation that of all RAS /TOSS (Tear Off Shingle) material is from a MPCA certified supplier.	Test as directed by the Bituminous Engineer or the District Materials Engineer..	Test Report
2360	Mineral Filler (QA only)	2360	One (1) sample per shipment of 50 tons (45 metric tons) or less, unless previously inspected.	Testing as directed by the Engineer or the District Materials Engineer.	Test Report
2360	Additives (QA Only)	2360	Sample blended asphalt binder and additive, 1 qt. (1 L). Sample first shipment of each type of material, then submit one sample per 250,000 gal. (1,000 m3) (approximately 1,000 ton).	Testing as directed by the Engineer or the Chemical Laboratory Director.	Test report

II. Bituminous Construction Items for Specification 2360 (cont.)

B. BITUMINOUS PRODUCTION for Specification 2360

*Verification Testing

Verification Companion testing from Agency split sample is required to be performed and used as the next QC sample that day.

SAMPLE SIZE:

Aggregate for Gradation (QC/QA) 35 lb. (15 kg)
 Plus #4 Aggregate Type for Quality Testing 80 lb. (35 kg) for each source
 Minus #4 Aggregate Type for Quality Testing 35 lb. (15 kg) for each source
 RAP material for Quality Testing 80 lb. (35 kg) for each source
 RAS (Shingles) for Processed Gradation and Quality Testing 10 lb. (5 kg)
 Mixture Properties (QC/QA) 3 full 6" by 12" cylinder molds for QA 65 lb. (30 kg)
 TSR (QC/QA) 4 full 6" by 12" cylinder molds for QA 90 lb. (40 kg)
 Aggregate Specific Gravity (QC/QA) 90 lb. (40 kg)
 Asphalt Binder (QA) 1 qt (1 L)
 Emulsified Asphalt (QA) ½ gal (2 L)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2360	Aggregate Quality Testing Including aggregate specific gravity (QA Only)	2360		Take additional samples when aggregate qualities approach specification limits or when material variation is observed, take additional field samples as requested by Project Engineer. Take additional samples when material variation is observed in RAP or RAS take additional field samples as requested by Project Engineer.	Lab report
2360	Moisture Content in Mixture (QC/QA) Lab Manual 1855	2360	Sample and test as directed by the Engineer.		Test Summary Sheet (TSS)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2360	Asphalt Binder Content, % AC, ADD AC, AC/Total AC ratio (QC/QA, Verification*) Lab Manual 1851, 1852, 1853	2360	(a) Incinerator Oven MnDOT Lab Manual 1853 (b) Chemical Extraction MnDOT Lab Manual 1851 or 1852 REMARKS: Contractor selects one method at the beginning of the project (when material is submitted for Trial Mix Review) and use that method for the entire project. The Contractor and Engineer may agree to change test procedures during the construction of the Project. See Note #1, Note #2 & Note #4. A computer file of the plant's control settings is required every 20 minutes of production.	The inspector will witness all QC mixture sampling and take possession of their QA-Verification split of this sample immediately after the sample is split. At the end of the day randomly submit one of the QA-Verification splits to the District Lab for testing. Additional verification samples can be taken at any time or location. When additional verification samples are taken the contractor must test the Verification companion split of this sample and include the results in the QC program (Test Summary Sheet). The Agency reviews the computer files of the plant's control settings. REMARKS: See Note # 3 & Note #7	TSS
2360	Mixture Properties (QC/QA, Verification*) Maximum Specific Gravity Lab Manual 1807	2360	Contractor performs test 1807 REMARKS: See Note #1, Note #2, & Note #4.	The inspector will witness all QC mixture sampling and take possession of their QA-Verification split of this sample immediately after the sample is split. At the end of the day randomly submit one of the QA-Verification splits to the District Lab for testing. Additional verification samples can be taken at any time or location. When additional verification samples are taken the contractor must test the Verification companion split of this sample and include the results in the QC program (Test Summary Sheet). REMARKS: Note # 3 & Note #7	TSS
2360	Mixture Properties (QC/QA, Verification*) Gyratory Bulk Specific Gravity - 2 Specimen Average, Lab Manual 1806, 1820	2360	Contractor performs test 1806 REMARKS: See Note #1, Note #2, & Note #6.	The inspector will witness all QC mixture sampling and take possession of their QA-Verification split of this sample immediately after the sample is split. At the end of the day randomly submit one of the QA-Verification splits to the District Lab for testing. Additional verification samples can be taken at any time or location. When additional verification samples are taken the contractor must test the Verification companion split of this sample and include the results in the QC program (Test Summary Sheet). REMARKS: See Note #3 & Note #7.	TSS

II. Bituminous Construction Items for Specification 2360 (cont.)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2360	Mixture Properties (QC/QA, Verification*) Adjusted Asphalt Film Thickness (AFT), Air Voids, Fines to effective, CAA, FAA and Gradation. Lab Manual 1203, 1206, 1214, 1808, 1854	2360	Verification Companion testing from Agency split sample is required and used as a QC sample once per day. Bituminous mixes composed entirely of Class A and/or Class B aggregates are not required to be tested for CAA (Coarse Aggregate Angularity). REMARKS: See Note #1, Note #2, Note #4, Note #5, & Note #6. The production start-up testing rates for the CAA and FAA is 1 per 1000 tons for the first 2000 tons. After 2000 tons, 2 test per day for at least two days. Then CAA and FAA at a rate of 1 test per week, if the CAA and FAA exceed the requirements by 8% and 5% respectively, otherwise test daily.	The inspector will witness all QC mixture sampling and take possession of their QA-Verification split of this sample immediately after the sample is split. At the end of the day randomly submit one of the QA-Verification splits to the District Lab for testing. Additional verification samples can be taken at any time or location. When additional verification samples are taken the contractor must test the Verification companion split of this sample and include the results in the QC program (Test Summary Sheet). REMARKS: See Note # 3 & Note #7.	TSS
2360	Core Density and Thickness Lab manual 1810	2360	Contractor cuts two cores at each location. In the laboratory, measure, and saw cores into separate lifts. Sawing of cores into separate lifts is required. Schedule the approximate time of testing during normal project work hours so the Agency may observe and record the saturated surface dry and immersed weight of the cores. A completed Core Density Incentive/Disincentive worksheet is to be submitted to the Laboratory (Agency field or District/Division).	Complete core stationing spreadsheet to determine core locations and then mark all coring locations on the pavement. Once the Contractor has measured and sawed the Agency companion cores transport them to the Agency field lab or District Lab for testing. Transport the cores as soon as possible to the testing lab taking care to prevent damage due to improper handling or exposure to heat. Selects at least one of the two companion cores per lot to test for verification. REMARKS: Note #3 & Note #6.	Core Density Worksheet Core Density Incentive/Disincentive worksheet.
2360	Tensile Strength Ratio (T.S.R.) (QC/QA) Lab Manual 1813	2360	Sample as directed by the Engineer. When testing is required, complete testing within 72 hours after the sample is taken.	Test as directed by the Engineer. When testing is required, complete testing within 72 hours after the sample is taken.	TSR Worksheet

II. Bituminous Construction Items for Specification 2360 (cont.)

C. BITUMINOUS MATERIALS for Specification 2360					
Only Bituminous Materials from Certified Sources are allowed for use. The most current list of Certified Sources: http://www.dot.state.mn.us/products/index.html					
Minimum Sample Sizes:					
<u>Quality Sample Size for Lab Submittal:</u>					
Asphalt Binder (QA)/Cutback Asphalt (QA)					
Emulsified Asphalt (QA)					
1 qt (1 L) Metal can with pressure fit lid					
½ gal (2 L) plastic					
Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2360	Asphalt Binder (QA only)	3151.2	<p><u>Asphalt Supplier</u> QC testing is the responsibility of the bituminous material supplier as part of the Combined State Binder Certification program.</p> <p><u>During Asphalt Mixture Production</u> Obtain asphalt binder samples from a sampling valve located between the pump and the drum. Sample each type of asphalt binder used in mixture production after 50 tons of mixture has been produced, then sample at a rate of one per 250,000 gal [1,000,000 L]. A minimum of 1 gallon of binder must be drawn and wasted from the sampling valve before the actual sample is drawn. For batch plants, obtain the asphalt binder sample from the weigh pod. Provide asphalt binder sample in clean one L (1 qt) steel container. The Inspector will monitor the sampling the Contractor performs.</p>	<p><u>Asphalt Supplier</u> Random sampling of bituminous material at the asphalt supplier is discussed in the Combined State Binder Certification program arranged by the MnDOT Chemical Laboratory.</p> <p><u>During Asphalt Mixture Production</u> Observe contractor personnel taking sample from sampling valve and submit to MnDOT Chemical Lab</p>	2413 Asphalt Sample Identification Card
2201 2355 2356 2357 2514	Emulsified Asphalt (QA only)	3151.2	<p>QC testing is the responsibility of the bituminous material supplier as part of the Combined State Binder Certification program.</p> <p><u>Tack Coat</u> During mixture production the Contractor will sample first shipment, then submit one sample per 50,000 gal (200,000 L). Sample emulsified asphalt in clean ½ gal (2 L) plastic container with wide screw top and send to MnDOT Chemical Lab within 7 days of sampling.. Sample all emulsified asphalt from the distributor.</p>	<p><u>Asphalt Supplier</u> Random sampling of bituminous material at the asphalt supplier is discussed in the Combined State Binder Certification program arranged by the MnDOT Chemical Laboratory.</p> <p><u>Tack Coat</u> Observe contractor personnel taking sample from the distributor and submit to MnDOT Chemical Lab.</p>	2413 Asphalt Sample Identification Card

II. Bituminous Construction Items for Specification 2360 (cont.)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2357 2358 2514	Cutback Asphalt (QA only)	3151.2	QC testing is the responsibility of the bituminous material supplier as part of the Combined State Binder Certification program. <u>Tack Coat</u> During mixture production the Contractor will sample first shipment, then submit one sample per 50,000 gal (200,000 L). Sample emulsified asphalt in clean ½ gal (2 L) plastic container with wide screw top and send to MnDOT Chemical Lab within 7 days of sampling.. Sample all emulsified asphalt from the distributor.	Asphalt Supplier Random sampling of bituminous material at the asphalt supplier is discussed in the Combined State Binder Certification program arranged by the MnDOT Chemical Laboratory. <u>Tack Coat</u> Observe contractor personnel taking sample from the distributor. Cutback Asphalt should only be used in cold temperature applications with the Engineer's approval. Contact Bituminous Engineering Unit for cold temperature application guidelines.	2413 Asphalt Sample Identification Card

Note #1 All QA test samples shall be from split samples.

If a member of the monitoring team observes the Contractor Test, note and sign under remarks.

The Project Engineer is responsible for:

- 1.) Reviewing control charts & Test summary sheets for accuracy and completeness,
- 2.) Checking sampling and testing procedures,
- 3.) Discussing QC problems with the Contractor,
- 4.) Obtaining Verification Samples

Note #2 For Mixture Quality Management, acceptance will be based on Contractor's test results as verified by MnDOT test results.

Note #3 When a member of a monitoring team observes the Contractor test, note and sign under remarks.

Note #4

How to calculate the number of tests per day	Production Start-up testing rates (first 2000 tons of production)	Production testing rates (after 2,000 tons of mixture produced)
Divide daily tonnage by 500 and round up to next whole number	1 test/ 500 tons	
Divide daily tonnage by 1000 and round up to next whole number		1 test/ 1000 tons

Note #5 MnDOT projects will require the calculated Adjusted Asphalt Film Thickness (AFT). VMA will still be calculated for informational purposes, but will not be used for acceptance criteria. The adjusted AFT will be calculated each time a gradation test is required.

Note #6 Random number generation and determination of random sample location shall be consistent with the MnDOT Bituminous Manual Section 5-693.7 Table A or Section 5 of ASTM D3665. The Engineer may approve alternate methods of random number generation.

Note #7 QA samples retained for 10 calendar days and tested, if needed.

III. Construction Items for Bituminous Specialty Items include the following:

- 2350 Permeable Asphalt Stabilized Stress Relief Course (PASSRC) and Permeable Asphalt Stabilized Base (PASB)
- 2354 Micro-Surfacing
- 2355 Bituminous Fog Seal
- 2356 Bituminous Seal Coat
- 2356 Otta Seal
- 2356 Ultra-Thin Bonded Wearing Course (UTBWC)
- 2357 Bituminous Tack Coat
- 2360 Stone Matrix Asphalt (SMA)

Only Bituminous Materials from Certified Sources are allowed for use. The most current list of Certified Sources: <http://www.dot.state.mn.us/products/index.html>

SAMPLE TYPE	DESCRIPTION	SAMPLE LOCATION DETERMINED BY	SAMPLE TAKEN BY	SAMPLE TESTED BY
QC	Quality Control Testing performed by Contractor. Also known as Process Control Testing.	Contractor	Contractor	Contractor
QA	Quality Assurance Testing performed by the Agency. This test is performed on a companion sample to the Contractor's QC sample.	Contractor (mixture) Agency (density cores)	Contractor	Agency
Verification	A sample to assure compliance of the Contractor's Quality Control program. The results shall be included as part of the QA Testing Program.	Agency	Agency	Agency
Verification Companion	A companion sample to the Agency's Verification sample provided to the Contractor. The Contractor is required to test this sample. The results shall be used as part of the QC program.	Agency	Agency	Contractor
IAT	The Independent Assurance Sampling and Testing assures testers are sampling and testing properly and that equipment is calibrated correctly.	Agency	Contractor or Agency	Contractor or Agency

III. Construction Items for Bituminous Specialty Items (cont.)

Pay Item Number	Test Type	Material Spec. No.	Minimum Contractor Quality Control Testing Rate Minimum Sample Size	Minimum Agency QA/Verification (Acceptance)	Form No.
1. Mix Design (Pre-Production)					
(a) 2350 (b) 2350	(a) PASSRC (b) PASB	2350	Complete 1 Job Mix Formula (gradation blend only) per mix Submit to agency: 100 lbs each coarse agg., 35 lbs each fine agg. & 4 qt. asphalt binder	Agency Performs Mix Design	Approved Mix Design Report
(c) 2354	(c) Micro-Surfacing	2354	Complete 1 mix design per aggregate source. See specification or special provision. Submit to Agency: 150 lbs aggregate	Review Submitted Mix Design (See Note 1)	Approved Mix Design Report
(d) 2356	(d) Bituminous Seal Coat	2356	At least two weeks before beginning construction complete 1 design per mix and provide information to Engineer. See specification or special provision. Submit to Agency: 150 lbs aggregate	Review Submitted Mix Design (See Note 1)	Approved Mix Design Report
(e) 2356	(e) UTBWC	2356 UTBWC	Complete and submit 1 design per mix	Review Submitted Mix Design	Approved Mix Design Report
(f) 2360	(f) SMA	2360 SMA	Complete 1 design per mix Submit to Agency: 80 lb. (35 kg) - bituminous mixture plus 6 Gyratory specimens for TSR testing. 150 lbs +4 aggregate from IMF blend for VCA 80 lbs each coarse agg. & 30 lbs each fine agg for quality testing	Review & verify Submitted Mix Design Test as directed by the Engineer	Approved Mix Design Report
2. Production Gradation					
(a) 2350 (b) 2350	(a) PASSRC (b) PASB Lab manual 1202, 1203	2350	One per 1,000 ton with a minimum of one per day Submit to Agency: 35 lbs Note # 2	1/day	Test Report
(c) 2354	(c) Micro-Surfacing Lab manual 1202, 1203	2354	Stockpile: 1/1,500 tons (min. 1/day) Machine Hopper: 1/500 tons (min. 1/day) Submit to Agency: 30 lbs	1/1500 Ton or min 1 per project whichever is greater.	Test Report

III. Construction Items for Bituminous Specialty Items (cont.)

Pay Item Number	Test Type	Material Spec. No.	Minimum Contractor Quality Control Testing Rate Minimum Sample Size	Minimum Agency QA/Verification (Acceptance)	Form No.
(d) 2356	(d) Bituminous Seal Coat	2356	Stockpile: 1/1,500 tons (min. 1/ day) Chip Spreader Hopper: 1/day Submit to Agency : 30 lbs from Hopper	1/day	Test Report
(e) 2356	(e) Otta Seal Lab manual 1202, 1203				
(a) 2350 (b) 2350	3. Production % Crushing (CAA) (a) PASSRC (b) PASB Lab manual 1214	2350	One per 1,000 with a minimum one per day Submit to Agency: 35 lbs from Belt	1/day	Test Report
(a) 2354	4. Moisture (In Aggregate) (a) Micro-Surfacing Grading & Base manual, 5-692.245.B	2354	Machine Hopper: 1/500 tons (min. 3/day) Submit to Agency: 2 lbs	1/day	Test Report
(a) 2354	5. Sand Equivalence (a) Micro-Surfacing AASHTO T 176	2354	Stockpile or Machine Hopper: 1/500 tons (min. 1/day) Submit to Agency: 25 lbs	1/day	Test Report
(a) 2356	6. Flakiness Index (a) Bituminous Seal Coat Lab Manual 1223	2356	Sample taken from first load on first day Submit to Agency: 30 lbs	See Note 1	Test Report
(a) 2356	7. Bituminous Mixture Tests (a) UTBWC Lab Manual 1203, 1807, 1852, 1853, 1854	2356 UTBWC	Tests: % AC, Gradation, Max Gravity, Adjusted AFT Rate: (1/300 tons, min. 1 per day) Note #3: Submit to Agency: 20 lbs (1 cylinder from truck box)	1 per day	TSS

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Pay Item Number	Test type	Spec. No.	Minimum Contractor Quality Control Testing Rate Minimum Sample Size	Minimum Agency QA/Verification (Acceptance)	Form
(b) 2350	(b) PASSRC, PASB Bit Manual	3151	Test: Asphalt spot check Rate: minimum one per day		Test Report
c) 2360	(c) SMA Lab M 1203, 1204, 1205, 1211, 1214, 1806, 1807, 1808, 1813, 1853, 1854, 1855, AI SP-2 AASHTO T305	2360 SMA	Tests: % AC, Gradation, Max Gravity, Bulk Gravity, Voids, VMA, CAA, Draindown, , voids in coarse aggregate (VCA) fines/effective asphalt. Rate: (1/1000 tons, min. 1 per day) Aggregate sp gravity, mix moisture content to be tested as directed by the Engineer See Note: #3 Submit companion 1 per day to agency: 65 lb. (30 kg) 3 full 6" by 12" cylinder molds	Tests: % AC, Gradation, Max Gravity, Bulk Gravity, Voids, VMA, CAA, voids in coarse aggregate (VCA) fines/effective asphalt. See Note # 3 & Note #4	TSS
(b) 2356	8. Asphalt Binder (b) UTBWC	2356 UTBWC 3151	QC testing is the responsibility of the bituminous material supplier. Random sampling is arranged by the MnDOT Chemical Laboratory. Asphalt Binder: First load, then 1/250,000 gal. 1 qt Emulsified Asphalt: First load, then 1/50,000 gal. ½ gal*	Observe contractor personnel taking sample from sampling valve and submit to MnDOT Chemical Lab.	Test Report
(c) 2354 (d) 2356 (e) 2356 (f) 2357	(c) Micro-Surfacing (d) Bituminous Seal Coat (e) Otta Seal (f) Bituminous Tack Coat	2354, 2356, 3151	QC testing is the responsibility of the bituminous material supplier. Random sampling is arranged by the MnDOT Chemical Laboratory.	First load, then 1 / 50,000 gal. ½ gal*	Test Report
(g) 2360	(g) PASSRC, PASB (h) SMA	3151, 2360 SMA	QC testing is the responsibility of the bituminous material supplier. Random sampling is arranged by the MnDOT Chemical Laboratory. Asphalt Binder (1 qt): First load, then 1/250,000 gal. Note: SMA to be test as in Section C. BITUMINOUS MATERIALS for Specification 2360	Observe contractor personnel taking sample and submit to MnDOT Chemical Lab. Note: SMA to be test as in Section C. BITUMINOUS MATERIALS for Specification 2360.	Test Report

Pay Item Number	Test type	Spec. No.	Minimum Contractor Quality Control Testing Rate Minimum Sample Size	Minimum Agency QA/Verification (Acceptance)	Form
(a) 2354	9. Asphalt Binder Application Rate (a) Micro-Surfacing	2354	Verify Application rate 3/day	Verify Application rate 1/day	
(b) 2355 (c) 2356 (d) 2356 (e) 2357	(b) Fog Seal (c) Bituminous Seal Coat (d) Otta Seal (e) Bit Tack Coat	2355, 2356, 2357	Verify Application rate 1/day	Verify Application rate 1/day	
2399	10. Inertial Profiler	2399	Pass Annual Certification at MNROAD	Perform a side by side comparison with the MnDOT IP once a year.	Profile Summary

*Use plastic containers for Emulsified Asphalt Samples. Send to MnDOT Chemical Lab within 7 days of sampling.

Note 1: Contractor submits samples to Agency. Agency will test at their discretion, based upon prior experience with submitted aggregate.

Note 2: Run test on gradation sample taken from aggregate belt

Note 3: TSR testing on production mixture is at the discretion of the Engineer.

Note 4: Agency is not required to run draindown testing on QA/Verification samples.

IV. Concrete Construction Items (www.dot.state.mn.us/materials/concrete.html)

The testing rates shown in this Schedule of Materials Control are minimums. All samples shall be taken in a random manner using an appropriate number generator. Take as many tests as necessary to ensure quality concrete. **All field samples shall be taken at the point of placement unless otherwise allowed by the Engineer.**

It is recommended that the Agency Plant Monitor be present during critical pours, such as superstructure or paving concrete (i.e. 3Y33, 3Y36, 3Y46, 3A21).

If any field test fails, reject the concrete or if the Producer makes adjustments to the load to meet requirements, record the adjustments on the Certificate of Compliance and the Weekly Concrete Report. Retest the load and record the adjusted test results. Make sure the next load is tested before it gets into the work.

If batching adjustments are made at the plant, test the adjusted load, before it gets into the work. Continue to test the concrete when test results are inconsistent or marginal.

The first load of concrete for any pour must have passing air content and slump results, prior to placing.

Material not meeting requirements shall not knowingly be placed in the work. If failing concrete inadvertently gets placed in the work, review either the MnDOT Standard Specifications for Construction or contact the Concrete Engineering Unit for monetary deductions recommendations.

It is recommended that the Agency representative continually monitor the progress of all concrete pours in the field and review Certificates of Compliance. It is not a recommended practice to only perform minimum testing requirements and leave the pour.

Should circumstances arise on a project which makes the testing rate impractical, contact the Concrete Engineering Unit.

DEFINITIONS				
	Description	Sample Location Determined By	Sample Taken By	Sample Tested By
QC	Quality Control Testing performed by Contractor. Also known as Process Control Testing.	Contractor	Contractor	Contractor
QA	Quality Assurance Testing performed by the Agency. This test is performed on a companion sample to the Contractor's QC sample.	Contractor	Contractor	Agency
Verification	A sample to assure compliance of the Contractor's Quality Control program. The results shall be included as part of the QA Testing Program.	Agency	Agency	Agency
Verification Companion	A companion sample to the Agency's Verification sample provided to the Contractor. The Contractor <u>is required</u> to test this sample. The results shall be used as part of the QC program.	Agency	Agency	Contractor
IAST	The Independent Assurance Sampling and Testing assures testers are sampling and testing properly and that equipment is calibrated correctly.	Agency	Contractor or Agency	Contractor or Agency

Concrete Plant Batching Materials				
Remarks: (1) All materials must come from certified or qualified sources. All certified sources must state so on the delivery invoice. (2) The most current list of certified/approved sources can be found at www.dot.state.mn.us/products .				
Sample Sizes: Cementitious: 5 lb (2 kg) Admixture: 1/2 pt. (0.25 L) Producer obtains samples from dispensing tubes. Store samples in plastic container. Water: 1 gal (3.5 L) Store sample in a clean glass or plastic container.				
Pay Item No.	Material	Spec. No.	Minimum Required Sampling Rate for Laboratory Testing	Form No.
2301	Portland Cement	3101	For certified ready-mix and concrete paving: 1 sample when the plant is certified.	24300 ID Card Cement Samples
2302	Slag	3102	Take an additional sample: 1) At 6 months, if producing Agency concrete, 2) If the plant changes sources, or 3) As the Contract requires.	
2405	Blended Cement	3103	For precast concrete: 1 sample every 3 months during Agency production	24308 ID Card Fly Ash Samples
2411	Fly Ash	3115	The Producer obtains and stores the sample in a sealed container provided by the Agency, and includes the supplier's delivery invoice from which the sample is obtained.	
2412			Take additional samples as directed by the Concrete Engineer	2410 Sample ID Card
2422			For all concrete: 1 sample when the plant is certified.	
2452			Take additional samples: 1) At 3 month intervals during Agency production, 2) If the plant changes sources, or 3) As the Contract requires.	2410 Sample ID Card
2461			The Producer obtains and stores the sample in a sealed container provided by the Agency.	
2506			Take additional samples as directed by the Concrete Engineer	2410 Sample ID Card
2511			For all concrete: 1 sample when the plant is certified.	
2514			Take additional samples: 1) At 3 month intervals during Agency production, 2) If the plant changes sources, or 3) As the Contract requires.	2410 Sample ID Card
2519			The Producer obtains and stores the sample in a sealed container provided by the Agency.	
2521			Take additional samples as directed by the Concrete Engineer	2410 Sample ID Card
2531			For all concrete: 1 sample when the plant is certified.	
2533			Take additional samples: 1) At 3 month intervals during Agency production, 2) If the plant changes sources, or 3) As the Contract requires.	2410 Sample ID Card
2545			The Producer obtains and stores the sample in a sealed container provided by the Agency.	
2550			Take additional samples as directed by the Concrete Engineer	2410 Sample ID Card
2554			For all concrete: 1 sample when the plant is certified.	
2557			Take additional samples: 1) At 3 month intervals during Agency production, 2) If the plant changes sources, or 3) As the Contract requires.	2410 Sample ID Card
2564			The Producer obtains and stores the sample in a sealed container provided by the Agency.	
2565			Take additional samples as directed by the Concrete Engineer	2410 Sample ID Card
			For all concrete: 1 sample when the plant is certified.	
	Water	3906	1 sample from any questionable source	2410 Sample ID Card

IV. Concrete Construction Items (cont.) (www.dot.state.mn.us/materials/concrete.html)**Certified Ready-Mix - Concrete Plant Production****Remarks:**

- (1) Mix design is provided by MnDOT unless otherwise specified in the Contract.
- (2) All gradation and quality tests require companion samples. Samples taken at location identified on Contact Report located at plant.
- (3) Perform Quality testing as directed by the Concrete Engineer.
- (4) Record all gradation weights in metric.

Minimum Sample Sizes:**Gradation Test:**

3/4" Plus (+19 mm) 25 lb. (12 kg)
 3/4" Minus (-19 mm) 10 lb. (5 kg)
 CA-70 6 lb. (2.5 kg)
 CA-80, Sand 1.1 lb. (500 g)

Moisture Test:

Coarse Aggregate 2000 g
 Fine Aggregate 500 g

Quality Sample Size for Lab Submittal:

3/4" Plus (+19 mm) 50 lb. (24 kg)
 3/4" Minus (-19 mm) 30 lb. (15 kg)
 Fine Aggregate 30 lb. (15 kg)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2302	Gradation Testing (QC/QA) (5-694.145 and 5-694.148)	2461 3126 3137	When over 20 yd ³ (m ³) of Agency concrete produced per day: Coarse: 1 per 200 yd ³ (m ³) Fine: 1 per 200 yd ³ (m ³) Passing aggregate gradations are required prior to the start of concrete production each day. Performing testing on representative material at the end of the most recent day of production is allowed. Washing the fine aggregate gradation (QC) sample is not required when the result on the -75µm (#200) sieve of the unwashed sample is less than 1.0%. Hold QA (QC companion) samples until they are picked up by the Agency monitor. Discard after 14 calendar days if not picked up. For Contractor Mix Designs utilizing an approved JMF: 1 per 400 yd ³ (m ³) or completed every 4 hours, whichever results in the higher sampling rate.	None	21763 Concrete Aggregate Worksheet (QC/QA) 2449 Weekly Concrete Aggregate Report 21765 Concrete Aggregate Worksheet JMF (QC/QA)
2401					
2405					
2411					
2412					
2422					
2452					
2461					
2506					
2511					
2514					
2519					
2521					
2531					
2533					
2545					
2550					
2554					
2557					
2564					
2565					

Certified Ready-Mix - Concrete Plant Production (cont.)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2302 2401 2405 2411 2412 2422 2452 2461 2506 2511 2514 2519	Gradation Testing (Verification/ Verification Companion) (5-694.145 and 5-694.148)	2461 3126 3137	Test the Verification Companion sample. Complete on the day the sample was taken. Wash all fine aggregate Verification Companion samples.	Coarse and Fine: 1 Verification sample per week when Agency production is 1 or 2 days per week. 2 Verification samples per week when Agency production is 3 or more days per week. For small quantities: When less than <u>25 yd³ (m³)</u> of Agency concrete is produced <u>per week</u> , Verification samples are not required Include verification companion results on Sample ID Card.	2449 Weekly Concrete Aggregate Report 24143 Weekly Certified Ready-Mix Plant Report (Verification)
2521 2531 2533 2545 2550 2554 2557	Quality Testing including Coarse Aggregate Testing on - #200 (-75µm) (5-694.146)	3126 3137	Test at Contractor's Discretion	1 test each fraction per month Identify quality samples with a "Q" on the Sample ID Card and the Quality companion sample.	2410 Sample ID Card
2564 2565	Aggregate Moisture Testing (QC) (5-694.142)	2461	When over 20 yd³ (m³) of Agency concrete produced per day: Coarse and Fine: 1 per 200 yd ³ (m ³) or completed every 4 hours, whichever results in the higher sampling rate. - Complete the initial moisture content and adjust the batch water prior to the start of concrete production each day. - If weather conditions allow, performing moisture testing on representative material at the end of production the prior evening is allowed. In this event, the four-hour rate will commence with the first pour of the day, regardless if it is placed in Agency or private work.	None	2152 Concrete Batching Report

IV. Concrete Construction Items (cont.) (www.dot.state.mn.us/materials/concrete.html)**Concrete Pavement - Concrete Plant Production****Remarks:**

- (1) Mix Design is Contractor's responsibility with review by MnDOT unless otherwise specified in the Contract.
- (2) Use Certified Ready-Mix - Concrete Plant Production testing rates schedule when:
 - a) The entire concrete paving project is < 3,500 cu. yd (2,900 m³)
 - b) When a secondary plant is used to provide minor work.
- (3) When w/c incentives apply according to 2301:
 - a) Contractor QC Technician and Agency Plant Monitor are required to be present during the entire pour. **If w/c incentives do not apply, the Agency Plant Monitor shall monitor as necessary to ensure compliance with the requirements of the Contract.**
 - b) A certified ready-mix plant shall be **dedicated (provides concrete only to the concrete paving project)**.
- (4) All gradation samples shall be taken in the presence of the Agency, unless otherwise authorized by the Engineer. All samples shall be taken off the belt leading to the weigh hopper unless otherwise approved by the Engineer. All gradation and quality tests require companion samples.
- (5) Perform Quality testing as directed by the Concrete Engineer.

Minimum Sample Sizes:**Gradation Test:**

3/4" Plus (+19 mm) 25 lb. (12 kg)
 3/4" Minus (-19 mm) 10 lb. (5 kg)
 CA-70 6 lb. (2.5 kg)
 CA-80, Sand 1.1 lb. (500 g)

Moisture Test:

Coarse Aggregate 2000 g
 Fine Aggregate 500 g

Quality Sample Size for Lab Submittal:

3/4" Plus (+19 mm) 50 lb. (24 kg)
 3/4" Minus (-19 mm) 30 lb. (15 kg)
 Fine Aggregate 30 lb. (15 kg)

75µm (#200) Coarse Aggregate Sample Size
 3/4" Plus (+19 mm) 10 lb. (5000 g)
 3/4" Minus (-19 mm) 6 lb. (2500 g)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2301	Gradation Testing (QC/QA) (5-694.145 and 5-694.148)	3126 3137	For a concrete paving batch plant: When over 250 yd³ (m³) is produced per day: 1 per 1500 yd ³ (m ³) or completed 1 per ½ day, whichever results in the higher sampling rate.	For a certified ready-mix plant: When over 20 yd³ (m³) is produced per day: 1 per 400 yd ³ (m ³) or completed every 4 hours, whichever results in the higher sampling rate.	21764 Concrete Aggregate Worksheet JMF Well-graded Concrete Aggregate Worksheet
			Performing testing on representative material at the end of the most recent day of production is allowed. If well-graded aggregate incentives apply: Use the Contractor's gradation results for well-graded aggregate incentive calculations as verified by Agency testing	Test the first 4 QA samples of production each time the Contractor mobilizes the plant or changes aggregate sources. For a concrete paving batch plant: 1 per day on randomly selected samples thereafter. For a certified ready-mix plant: 1 per 1000 yd ³ (m ³) or 1 per week, whichever results in higher sampling rate on randomly selected samples thereafter.	
			Identify the gradation samples with "QA Gradation" on the Sample ID Card and include the JMF Number and the QC Gradation results. If Coarse Aggregate Quality Incentive/Disincentives apply: The Agency may also use the QA gradation sample for the Coarse Aggregate Quality incentive/disincentive testing. In this case, notify the Producer/Contractor to double the QC/QA gradation sample size.		

Concrete Pavement - Concrete Plant Production (cont.)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.		
2301	Coarse Aggregate Testing on -#200 (-75µm) (QC/QA) (5-694.146)	3137	Test the first sample and then at least 1 of the next 3 samples on the first day of production and each time the Contractor mobilizes the plant, changes aggregate sources, or the cleanliness of the coarse aggregate is in question. 1 test per day thereafter Test these samples at the plant.	For a concrete paving batch plant: 1 randomly selected sample on the first day of production and each time the Contractor mobilizes the plant, changes aggregate sources, or the cleanliness of the coarse aggregate is in question. 1 test per week thereafter Test these samples at the plant.	For a certified ready-mix plant: 1 randomly selected sample on the first day of production and each time the Contractor mobilizes the plant, changes aggregate sources, or the cleanliness of the coarse aggregate is in question. 1 per 1000 yd ³ (m ³) or 1 per week, whichever results in the higher sampling rate on randomly selected samples thereafter.	21764 Concrete Aggregate Worksheet JMF - Paving	
			For a concrete paving batch plant: If w/c incentives do not apply: 1 per 1000 yd ³ (m ³) or completed every 4 hours, whichever results in the higher sampling rate.	For a certified ready-mix plant: If w/c incentives do not apply: 1 per 200 yd ³ (m ³) or completed every 4 hours, whichever results in the higher sampling rate.	For a concrete paving batch plant: If w/c incentives apply: 1 per 1000 yd ³ (m ³) or completed every 4 hours, whichever results in the higher sampling rate. Take initial samples for aggregate moisture testing within the first 250 yd ³ (m ³).	For a certified ready-mix plant: If w/c incentives apply: 1 per 200 yd ³ (m ³) or completed every 4 hours, whichever results in the higher sampling rate. Take initial samples for aggregate moisture testing within the first 100 yd ³ (m ³).	Concrete W/C Ratio Calculation Worksheet
			Complete the initial moisture content and adjust the batch water prior to the start of concrete production each day. If weather conditions allow, performing moisture testing on representative material at the end of production the prior evening is allowed.	If w/c incentives apply: Use aggregate moisture results for determining the water content to calculate the w/c ratio incentive/disincentive. Do not leave samples unattended.			

IV. Concrete Construction Items (cont.) (www.dot.state.mn.us/materials/concrete.html)

Concrete Pavement - Concrete Plant Production (cont.)					
Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2301	Water Content Verification Testing (Microwave Oven Verification) (5-694.532)	2301	Obtain the plastic concrete sample at the plant.	<p>If w/c incentives apply: Microwave oven verification testing to verify the w/c ratio is completed in conjunction with Agency aggregate moisture testing.</p> <p>Do not leave samples unattended.</p> <p>For a concrete paving batch plant: Take initial sample for microwave oven verification testing within the first 250 yd³ (m³). At least one additional verification test should be taken if more than 1,000 yd³ (m³) is produced in a day.</p> <p>For a certified ready-mix plant: Take initial sample for microwave oven verification testing within the first 100 yd³ (m³). At least one additional verification test should be taken if more than 400 yd³ (m³) is produced in a day.</p>	Concrete W/C Ratio Calculation Worksheet
	Unit Weight (QC) (5-694.542)		Test one load of concrete per day at the plant.	None	
	Air Content for Type 3 Concrete (QC) (5-694.541)	2461	Test the first load of concrete at the plant.	None	

Concrete Pavement - Concrete Plant Production (cont.)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.
2301	Quality Testing including Coarse Aggregate Testing on - #200 (-75µm)	3126 3137	<p>Prior to concrete production: Test the Agency's pre-production sample at the Contractor's discretion</p> <p>During concrete production: Test the -#200 (-75µm) on the Quality companion sample the day it was sampled.</p> <p>All other testing is at the Contractor's discretion</p>	<p>Prior to concrete production for the primary concrete plant: Obtain pre-production samples for quality testing at least 16 hours prior to concrete production. Samples may be taken from the stockpile and the -#200 (-75µm) test may be performed at the lab instead of at the plant at the discretion of the Engineer. If the Entire Project is < 3,500 cu. yd (2,900 m³), pre-production sampling is not required.</p> <p>During concrete production: 1 randomly selected test each fraction every 20,000 yd³ (m³) of production.</p> <p>Split the Quality sample 4 ways: 1) Provide 2 quarters of the sample to the Producer/Contractor. 2) Test the -#200 (-75µm) on the quality sample at the plant the day it was sampled. 3) Submit the remaining sample to the lab for quality testing including testing on the -#200 (-75µm) sieve.</p> <p>Identify quality samples with a "Q" and record the QC and QA -#200 (-75µm) test results on the Sample ID Card.</p> <p>Identify the Quality Companion samples with a "Q".</p> <p>See additional requirements for first sand quality sample under ASR Testing.</p>	2410 Sample ID Card
2301	Alkali Silica Reactivity (ASR) Testing	2301	None	<p>1 per paving project per sand source</p> <p>Provide one 5 lb sample of: 1) cement, and 2) supplementary cementitious material (fly ash or slag), 3) with the first sand quality.</p> <p>Write "Project Specific ASR Testing" on all 3 Sample ID cards.</p> <p>If the Entire Project is < 3,500 cu. yd (2,900 m³), ASR testing is not required.</p>	2410 Sample ID Card 24300 ID Card Cement Samples 24308 ID Card Fly Ash Samples

IV. Concrete Construction Items (cont.) (www.dot.state.mn.us/materials/concrete.html)

Concrete Pavement - Concrete Plant Production (cont.)					
Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	
2301	Coarse Aggregate Quality Testing for Incentive/Disincentive	3137	Test at Contractor's discretion	If coarse aggregate quality incentives apply: Test the Class B aggregates for % absorption and Class C aggregates for % carbonate including any other tests necessary to make those determinations. Sample the 2 largest fractions in accordance with the following table and 2301:	
				Coarse Aggregate Quality Incentive/Disincentive Sampling Rates	
				Plan Concrete cu. yd [cu. m]	
				3,500 – 7,500 [2,900 – 6,250]	
				7,501 – 10,000 [6,251 – 8,500]	
				10,001 – 25,000 [8,501 – 21,000]	
				25,001 – 50,000 [21,001 – 42,000]	
				> 50,000 [42,000]	
				Identify incentive samples on the Sample ID Card with "I/D"	
				Samples per fraction (n)	
3					
5					
10					
15					
20					
Form No. 2410 Sample ID Card Coarse Aggregate Quality Incentive/Disincentive Worksheet					

2410
Sample ID
Card

Coarse
Aggregate
Quality
Incentive/
Disincentive
Worksheet

Concrete Field Materials (Refer to Metallic Materials and Metal Products for sampling requirements for concrete reinforcement.)			
Sample Sizes: Joint Materials: Hot Poured Elastomeric: 5 lb. (2.26 kg) Take samples from application wand, store in steel (1 gal) container. Preformed Elastomeric: 6 ft (2 m) Silicone Joint Sealer: 1 pt. (0.5 L) Store sample in steel container. Preformed: 2 ft ² (0.25 m ²) Curing Materials: Burlap: 1 yd ² (m ²) Paper and Plastic: 2 ft ² (0.25 m ²) Membrane Compound 1 qt. (1 L) If sampling is required, materials must be thoroughly stirred or agitated immediately prior to taking sample. Store sample in steel container and cover immediately.			
Pay Item No.	Material	Spec. No.	Minimum Required Field Sampling Rate
2301 2302 2401 2411 2514 2521 2531	Preformed	3702	Visual Inspection
2301 2302 2401	Preformed Elastomeric Type	3721	1 per lot
	Silicone Joint Sealer	3722	Only joint materials from qualified sources are allowed. The most current lists can be found at www.dot.state.mn.us/products
	Hot Poured Elastomeric Type	3723 3725	
2301 2302 2401 2411 2514 2520 2521 2531 2533	Burlap	3751	Visual Inspection
	Paper	3752	Visual Inspection - Must be white opaque
	Membrane Curing Compound	3754 3754AMS 3755	Visual Inspection -- Use only Pre-Approved Curing Compounds. Refer to the approved products list of curing compounds for pre-approved lots at http://www.mnrrapps.dot.state.mn.us/CuringCompoundProducts/curingcompounds.aspx
	Plastic	3756	Visual Inspection -Must be white opaque and free from holes.
			A Certificate of Compliance shall be submitted to the Project Engineer from the Manufacturer certifying that the plastic complies with AASHTO M171.

2410 Sample ID Card

IV. Concrete Construction Items (cont.) (www.dot.state.mn.us/materials/concrete.html)**Concrete Field Testing – Bridges and General Concrete**

Pay Item No.	Test Type	Spec. No.	Agency Testing	Form No.
2302	Air Content for Type 3 Concrete (Verification) (5-694.541)	2461	1 per 100 yd ³ (m ³) Test first load each day per mix	2448 Weekly Concrete Report
2401			Test when adjustments are made to the mix.	
2405			1 per 100 yd ³ (m ³) Test first load each day per mix	
2411	Slump (Verification) (5-694.531)	2461	Test as necessary to verify passing slump	
2412			No slump testing required for slipform placement	
2422			Record temperature each time air content, slump, or strength test specimen is performed/fabricated.	2409 ID Card Concrete Test Cylinder
2452	Concrete Temperature (Verification) (5-694.550)	2461		
2461			1 cylinder (28-day) per 100 yd ³ (m ³) 1 cylinder (28-day) per day for sidewalk and curb and gutter	
2506	Compressive Strength (Verification) (5-694.511)	2461	Cast up to three (3) control cylinders. Any additional control cylinders are the responsibility of the Contractor. MnDOT standard cylinder mold size is 4 x 8 inch (100 x 200 mm). If aggregate has a maximum size greater than 1-1/4 inch (31.5 mm), use 6 x 12 inch (150 x 300 mm) molds.	
2511				
2514				
2520				2409 ID Card Concrete Test Cylinder
2521				
2531				
2533				
2545				
2550				2409 ID Card Concrete Test Cylinder
2554				
2557				
2564				
2565				

Concrete Field Testing – Cellular Concrete

Pay Item No.	Test Type	Spec. No.	Agency Testing	Form No.
2519	Compressive Strength (Verification) (5-694.511)	2461 2519	1 set of 4 cylinders (28-day) per day 4 x 8 inch (100 x 200 mm) cylinders shall be filled in two equal lifts, do not rod the concrete, lightly tap the sides, cover and move to area with minimal or no vibration. Do not disturb for 24 hours.	2409 ID Card Concrete Test Cylinder

Concrete Field Testing – Concrete Pavement

Pay Item No.	Test Type	Spec. No.	Contractor Testing	Agency Testing	Form No.
2301	Air Content Before Consolidation for Type 3 Concrete (QC/QA) (5-694.541)	2461	1 per 300 yd ³ (m ³) or 1 per hour, whichever is less Test first load each day per mix	1 correlation air test per day	2448 Weekly Concrete Report
	Air Content After Consolidation for Type 3 Concrete (QC/QA) (5-694.541)	2461	Test 1 air content per ½ day of slip form paving to establish an air loss correction factor (ACF). See Special Provisions for additional information.	1 air test per day	
	Slump (QC/QA) (5-694.531)	2461	For fixed form placement: 1 per 300 yd ³ (m ³) and as directed by the Engineer Test first load each day per mix For slipform placement: No slump testing is required	For fixed form placement: 1 slump test per day For slipform placement: No slump testing is required	
	Concrete Temperature (QC/QA) (5-694.550)	2461	Record temperature each time air content, slump or strength test specimen is performed/fabricated by the Contractor.	Record temperature each time air content, slump or strength test specimen is performed/fabricated by the Agency.	
	Flexural Strength (QC) (5-694.521)	2301	1 beam (28-day) per day - Make additional control beams as necessary. - Control beams shall be made <u>within the last hour</u> of concrete poured each day. Fabricate beams, deliver beams to curing site, and clean beam boxes. Cylinders may be substituted for beams at the discretion of the Engineer	Supply beam boxes, cure, and test beams. MnDOT standard beam box size is 6" x 6" x 20" unless other sizes or types are approved by the Concrete Engineer.	2162 Concrete Test Beam Data
	Concrete Pavement Texture (QC)	2301	1 per 1000 linear feet per lane of concrete pavement at locations determined by the Agency. All adjoining lanes shall be tested at the same location if paved at the same time. The Contractor supplies all materials necessary to perform the required testing.	Determine texture testing locations using random numbers.	Concrete Texture Worksheet

IV. Concrete Construction Items (cont.) (www.dot.state.mn.us/materials/concrete.html)

Concrete Field Testing – Concrete Pavement (cont.)					
Pay Item No.	Test Type	Spec. No.	Contractor Testing	Agency Testing	Form No.
2301	Thickness (QC/Verification)	2301	The Contractor drills concrete cores at locations determined by the Agency. The Contractor probes the plastic concrete at locations determined by the Agency.	Determine probing and coring locations using random numbers. Initial pavement at core locations and re-initial the sides of specimens after coring to clearly verify their authenticity.	24327 Field Core Report Probing and Coring Report
2301	Surface Smoothness	2301	Contractor provides MnDOT certified inertial profiler results for the entire project as required by the Contract.	None	Concrete Profile Summary Worksheet

Concrete Field Testing - Low Slump Concrete for Bridge Deck Overlays**Remarks:**

- (1) Mix design is provided by MnDOT on the back of the Form 21412 Weekly Report of "Low Slump Concrete" unless otherwise specified in the Contract.
- (2) All field gradation samples shall be taken by the Agency. All gradation and quality tests require companion samples.
- (3) Perform Quality testing as directed by the Concrete Engineer.

Minimum Sample Sizes:**Gradation Test:**

CA-70 6 lb. (2.5 kg)
Sand 1.1 lb. (500 g)

Quality Sample Size for Lab Submittal:

Coarse Aggregate 50 lb. (24 kg)
Fine Aggregate 30 lb. (15 kg)

Pay Item No.	Test Type	Spec. No.	Contractor Testing	Agency Testing	Form No.
2404	Gradation and Quality Testing including Coarse Aggregate Testing on - #200 (-75µm) (QC/Verification) (5-694.145, 5-694.146 and 5-694.148))	3126 3137	Prior to concrete production, the Contractor shall provide the Agency with: <ul style="list-style-type: none"> Aggregate pit numbers 1 passing gradation result per aggregate fraction per source No quality test results are required. Test companion samples at Contractor's discretion.	1 per aggregate fraction prior to concrete production and each time aggregate is delivered to the site. Identify quality samples with a "Q" on the Sample ID Card and the Quality companion sample.	2410 Sample ID Card 21412 Weekly Report of "Low Slump Concrete"
	Air Content for Type 3 Concrete (Verification) (5-694.541)	2461	None	1 per 15 yd ³ (m ³) Test at beginning of pour each day	
	Slump (Verification) (5-694.531)	2461	None	1 per 15 yd ³ (m ³) Test at beginning of pour each day For concrete from a concrete-mobile, allow mix to hydrate 4 to 5 minutes before slump test to assure all cement is saturated.	
	Compressive Strength (Verification) (5-694.511)	2461	None	1 cylinder (28-day) per 30 yd ³ (m ³)	2409 ID Card Concrete Test Cylinder

Concrete Field Testing – Concrete Pavement Repair (CPR) for 3U18**Remarks:**

- (1) Mix design is provided in accordance with MnDOT Spec 3105 unless otherwise specified in the Contract.
- (2) Testing rates apply to concrete that is produced on site.
- (3) All field gradation samples shall be taken by the Agency. All gradation and quality tests require companion samples.
- (4) Perform Quality testing as directed by the Concrete Engineer.

Minimum Sample Sizes:**Gradation Test:**

3/4" Minus (-19 mm)	10 lb. (5 kg)
CA-70	6 lb. (2.5 kg)
CA-80, Sand	1.1 lb. (500 g)

Quality Sample Size for Lab Submittal:

Fine Aggregate	30 lb. (15 kg)
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Pay Item No.	Test Type	Spec. No.	Contractor Testing	Agency Testing	Form No.
2302	Gradation and (QC/Verification) (5-694.145 and 5-694.148)	3126 3137	Prior to concrete production, the Contractor shall provide the Agency with: <ul style="list-style-type: none"> Aggregate pit numbers 1 passing gradation result per aggregate fraction per source. Test companion samples at Contractor's discretion.	1 per aggregate fraction prior to concrete production and each time aggregate is delivered to the site.	2410 Sample ID Card
	Quality Testing including Coarse Aggregate Testing on - #200 (-75µm) (5-694.146)	3126 3137	No quality test results are required.	1 test each aggregate fraction per source The Agency may use the gradation results for the Quality Samples as a substitute for 1 required field gradation. Identify quality samples with a "Q" on the Sample ID Card and the Quality companion sample.	2410 Sample ID Card
	Air Content for Type 3 Concrete (Verification) (5-694.541)	2461	None	1 per 15 yd ³ (m ³) Test at beginning of pour each day.	2448 Weekly Concrete Report

Concrete Field Testing – Concrete Pavement Repair (CPR) for 3U18 (cont.)**Remarks:**

- (4) Mix design is provided in accordance with MnDOT Spec 3105 unless otherwise specified in the Contract.
 (5) Testing rates apply to concrete that is produced on site.
 (6) All field gradation samples shall be taken by the Agency. All gradation and quality tests require companion samples.
 (5) Perform Quality testing as directed by the Concrete Engineer.

Minimum Sample Sizes:**Gradation Test:**

3/4" Minus (-19 mm) 10 lb. (5 kg)
 CA-70 6 lb. (2.5 kg)
 CA-80, Sand 1.1 lb. (500 g)

Quality Sample Size for Lab Submittal:

Fine Aggregate 30 lb. (15 kg)

Pay Item No.	Test Type	Spec. No.	Contractor Testing	Agency Testing	Form No.
2302	Slump (Verification) (5-694.531)	2461	None	1 per 15 yd ³ (m ³) Test at beginning of pour each day. Allow mix to hydrate 5 minutes before slump test to assure all cement is saturated.	
	Compressive Strength (Verification) (5-694.511)	2461	None	1 cylinder (28-day) per 30 yd ³ (m ³)	2409 ID Card Concrete Test Cylinder

IV. Concrete Construction Items (cont.) (www.dot.state.mn.us/materials/concrete.html)

Concrete Field Testing –Dowel Bar Retrofit (DBR) Remarks: (1) Mix Design is Contractor's responsibility with review by MnDOT unless otherwise specified in the Contract. (2) Testing rates apply to concrete that is produced on site. (Not from a certified ready-mix plant.) (3) All field gradation samples shall be taken by the Agency. All gradation and quality tests require companion samples. (4) Perform Quality testing as directed by the Concrete Engineer.					
Minimum Sample Sizes: Gradation Test: CA-80, Sand 1.1 lb. (500 g)					
Quality Sample Size for Lab Submittal: Coarse Aggregate 50 lb. (24 kg) Fine Aggregate 30 lb. (15 kg)					
Pay Item No.	Test Type	Spec. No.	Contractor Testing	Agency Testing	Form No.
2302	Gradation and Quality Testing including Coarse Aggregate Testing on - #200 (-75µm) (QC/Verification) (5-694.145, 5-694.146) and 5-694.148)	3126 3137	Prior to concrete production, the Contractor shall provide the Agency with: <ul style="list-style-type: none"> Aggregate pit numbers 1 passing gradation result per aggregate fraction per source. No quality test results are required. Test companion samples at Contractor's discretion.	1 per aggregate fraction prior to concrete production and each time aggregate is delivered to the site. Identify quality samples with a "Q" on the Sample ID Card and the Quality companion sample.	2410 Sample ID Card
	Dowel Bar Retrofit Material Compressive Strength (Verification) (5-694.511)	2301 2302	None	During the pre-production test operations: 1 set of 3 cylinders tested at a rate as directed by the Engineer. Testing may need to be repeated if any problems with the dowel bar retrofit material are encountered. First day of production: 1 set of 3 cylinders tested at a rate as directed by the Concrete Engineer. After the first day of production: 1 cylinder per day during production tested at rate determined by Engineer to determine opening to traffic strength.	2409 ID Card Concrete Test Cylinder

Pay Item No	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2105 2571 2575	1. Manufactured Topsoil borrow ^a Salvaged Topsoil (stockpiled)	3877.2	None	From each source: One composite sample for the first 765 m ³ (1,000 Cu yd). One composite sample for each additional 2,300 m ³ (3,000 Cu yd). Small quantities under 75 m ³ (100 Cu yd.), no sample required. One composite sample for each stockpiled topsoil, test for fertility.	10 kg (20 lb.)	^a Test results showing meets specifications. Testing for all topsoil for fertility by Contractor at Certified Soils Lab. Sampling shall be done once source is identified or existing topsoil is stockpiled.
2571 2575 2577	2. Plant Stock & Landscape Materials ^b	3861 and 2571.2A1	Field Inspection at Job Site, submit itemized report for each shipment ^c			^b Preliminary inspection will not be done at the source. Material must be in accordance with the Inspection and Contract Administration Guidelines for MnDOT Landscape Projects. ^c Utilize "Inspection and Contract Administration Guidelines for MnDOT Landscape Projects" to determine and measure minimum and maximum criteria thresholds. The following documentation must be provided: 1. A MnDOT Certificate of Compliance for Plant Stock, Landscape Materials, and Equipment 2. A valid copy of a nursery stock (dealer or grower) certificate registered with the MN Dept. of Agric. And/or a current nursery certificate/license from a state or provincial Dept. of Agric. for each plant stock supplier. 3. A copy of the most recent Certificate of Nursery Inspection for each plant stock supplier. 4. Plant material shipped from out-of-state nursery vendors subject to pest quarantines must be accompanied by documentation certifying all plants shipped are free of regulated pests. 5. Bills of lading (shipping documents) for all materials delivered. 6. Invoices for all materials to be used. 7. Each bundle, bale, or individual plant must be legibly and securely labeled with the name and size of each species or variety.
2502 2573 2575 2577	3. Erosion Control Blanket ^d	3885	Visual Inspection	Random - See Footnote ^d		^d Check Web site for list of approved products.. www.dot.state.mn.us/products

V. Landscaping and Erosion Control Items (cont.)

Pay Item No	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2573 2577	4. Erosion Control Netting ^e	3885	Visual Inspection			^e Check Web site for list of approved products. www.dot.state.mn.us/products
2573	5. Silt Fence ^f	3886	Check Product Label. Obtain Certificate of Compliance with MARV values			^f Check Approved/Qualified Products List (A/QPL) of accepted geotextiles www.dot.state.mn.us/products
2573	6. Flotation Silt Curtain ^g	3887	Visual Inspection			^g Accepted, based on manufacturers' certification of compliance. Check weight of fabric.
2573 2575	7. Erosion Stabilization Mat ^h	3885	Visual Inspection			^h Check Web site for list of approved products. www.dot.state.mn.us/products
2573	8. Filter Logs	3897	Visual Inspection	None		
2573	9. Flocculants ⁱ	3898	Visual Inspection	None		ⁱ Certificate of Compliance and MSDS to the Engineer.
2571 2575	10. Fertilizer ^j	3881	Visual Inspection			^j Bagged: Inspected on the basis of guaranteed analysis. Rate based on fertility analysis of slope dressing/topsoil. Bulk: Inspector to obtain copy of invoice of blended material stating analysis. Check the type specified.
2571 2575	11. Agricultural Lime ^k	3879	One gradation test for each 180 Metric Ton (200 ton)			^k Contractor must supply amount of ENP (Equivalent Neutralizing Power) for each shipment.
2575 2577	12. Mulch Material A. Type 3 Mulch - Certified Weed Free (Certified sources only) ^l	3882	Visual Inspection, Check if from Certified Vendor by Minnesota Crop Improvement Association. Must be tagged, grain straw only.			^l Certified mulch will be indicated by label.

Pay Item No	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2571 2575 2577	13. Mulch Material B. Type 6 Mulch – Woodchips	3882	Visual Inspection, one gradation per supplier. Obtain Certificate of Compliance.	Gradation 1/10,000 yd ³ per supplier.		All wood chips supplied by a supplier outside the Emerald Ash Borer quarantine area or have an Emerald Ash Borer Compliance Agreement with the MDA.
2502 2575 2577	14. Seeds A. Seeds (Certified Vendors Only) (Mixes 22-000 and 25-000 series) ^m	3876	Check for Certified Vendor tag from Minnesota Crop Improvement Association. If materials are on hand and past the twelve months, testing must be done.			^m Periodic sampling taken by Office of Environmental Services. Any moldy or insect contaminated seed must be rejected.
2502 2575 2577	14. Seeds B. Native Seed (Mixes 30-000 series) certified seed only ⁿ	3876	Check if from Certified Vendor by Minnesota Crop Improvement Association. Must be tagged. If materials are on hand and past the twelve months, testing must be done.			ⁿ Certified seed will be indicated by label on containers. Reject all moldy or insect contaminated seed. Periodic sampling taken by Office of Environmental Services.
2575	15. Sod ^o	3878	A certified tag by Minnesota Crop Improvement Association for Salt tolerant sod. Final Visual Inspection at site.			^o A Certificate of Compliance must be furnished by the producer to the Engineer for the type of sod supplied showing correct grass varieties.
2571 2575	16. Compost A. Compost Certified Source ^p	3890	Visual Inspection			^p Check Approved/Qualified Products List (A/QPL), retain Certificate of Compliance.
2571 2575	17. Compost B. Compost Non-Certified Source ^q	3890	Inspection of source 6 weeks prior to delivery.			^q Retain Certificate of Compliance, 6 weeks prior to delivery.
2575	18. Hydraulic Soil Stabilizer ^r	3884		None		^r Check Approved/Qualified Products List (A/QPL). Installer needs to show certificate of training.

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2401	Asphalt Plank	3204	Visual Inspection	1 per 1,000 plank or less of each thickness in each shipment	3 – 1 m (yd) pieces from different planks	
2131	Calcium Chloride	3911	Visual Inspection	Liquid: 1 per 40,000 L (1 per 10,000 gal) Dry: 1 per shipment	0.5 L (1 pint) or 0.5 kg (1 lb.) in Plastic Container	
2131	Magnesium Chloride	3912	Visual Inspection	1 per 40,000 L (1 per 10,000 gal.)	0.5 L (1 pint) in Plastic Container	
2331	Hot-Pour Crack Sealant for Crack Sealing/Filling	3719 3723 3725	Visual Inspection	1 per lot. Take samples from application wand. Use caution when handling hot containers	2.26 kg (5 lb.) in a 1 gal steel container.	
2331	Pavement Joint Adhesive	Special Provisions	Visual Inspection	1 per lot. Take samples from application wand. Use caution when handling hot containers	2.26 kg (5 lb.) in a 1 gal steel container	2410 Sample ID Card –including manufacturer and lot number
2481	Waterproofing Materials Membrane Waterproofing System	3757	Visual Inspection	1 per shipment (Membrane Only)	0.1 m ² (1 Sq Ft)	Only waterproofing systems from qualified sources are allowed for use. The most current list can be found at www.dot.state.mn.us/products Membrane Waterproofing System: The manufacturer shall submit a one square foot sample of the membrane along with a letter of Certification and test results stating that the membranes meet the requirements of this specification. Other components of the waterproofing system do not need to be sampled for testing.

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2481	Waterproofing Materials Three Ply System Asphalt Primer	3165	Visual Inspection	1 per shipment	0.5 L (1 pt.) in steel container	
2481	Waterproofing Materials Three Ply System Waterproofing Asphalt	3166	Visual Inspection	1 per shipment	0.5 L (1 pt.) in steel container	
2481	Waterproofing Materials Three Ply System Fabric	3201	Visual Inspection	1 per shipment	1 m ² (1 Sq yd)	
2582	Waterborne Latex Traffic Marking Paint.	3591	Visual Inspection	1 per lot	0.5 L (1 pint)	Form 02415 List batch numbers and retain Certificate of Compliance. Only traffic marking paints from Qualified Products List are allowed for use. The most current Qualified Products list can be found at www.dot.state.mn.us/products
2582	Epoxy Traffic Paint	3590	Visual Inspection	1 Part A per lot 1 Catalyst Part B per lot	0.5 L (1 pint)	Form 02415 List batch numbers and retain Certificate of Compliance. Only traffic marking paints from Qualified Products List are allowed for use. The most current Qualified Products list can be found at www.dot.state.mn.us/products
2582	Traffic Marking Paint	Special Provisions	Visual Inspection	1 Part A per lot 1 Catalyst Part B per lot	0.5 L (1 pint)	Form 02415 List batch numbers and retain Certificate of Compliance. Only traffic marking paints from Qualified Products List are allowed for use. The most current Qualified Products list can be found at www.dot.state.mn.us/products For traffic marking paints other than Waterborne Latex and Epoxy. See Special Provision for Qualified Products List.
2564	Non-Traffic Striping Paints	3500 Series Special Provisions	Visual Inspection		0.5 L (1 pint)	Form 02415 List batch numbers and retain Certification of Compliance. For all others, see Special Provisions. Send color sample to Chemical Laboratory for color matching.

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2478	Bridge Structural Steel Paint	3520	Visual Inspection	Certificate of Compliance with each batch/lot for each component of the paint system to the Engineer. Provide a color "Draw Down" sample to the MnDOT Chemical Laboratory for verification of the finish coat color		Form 02415 List batch numbers and retain Certificate of Compliance. Only paints from Approved Products List are allowed for use. The most current Approved Products List can be found at www.dot.state.mn.us/products
	Exterior Masonry Paint	3584	Visual Inspection	1 per lot Provide a color "Draw Down" sample to the MnDOT Chemical Laboratory for verification of the finish coat color.	0.5 L (1 pint)	Form 02415 List batch numbers and retain Certificate of Compliance Only paints from Approved Products List are allowed for use. The most current Approved Products List can be found at www.dot.state.mn.us/products
	Noise Wall Stain	Special Provisions	Visual Inspection	Certificate of Compliance for each batch/lot of paint. Provide a color "Draw Down" sample to the MnDOT Chemical Laboratory for verification of the finish coat color.		Form 02415 List batch numbers and retain Certificate of Compliance Only paints from Approved Products List are allowed for use. The most current Approved Products List can be found at www.dot.state.mn.us/
2582	Drop-on Glass Beads	3592	Visual Inspection	1 per lot	1 L (qt.)	Form 02415 List batch numbers and retain Certificate of Compliance Only glass beads from Qualified Products List are allowed for use. The most current Qualified Products List can be found at www.dot.state.mn.us/products
2502 2581 2582	Pavement Marking Tape	3354 3355 Special Provisions	Visual Inspection	1 clean sample of each color per lot	3 m (3 yds.)	Form 02415 List batch numbers and retain Certificate of Compliance. Only pavement marking tape from Qualified Products List are allowed for use. The most current Qualified Products List can be found at www.dot.state.mn.us/products

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2540 2563 2564 2565 2582	Signs and Markers	3352	Visual Inspection	None unless material suspect		Form 02415 Only Signs and Markers from Qualified Products List are allowed for use. The most current Qualified Products List can be found at www.dot.state.mn.us/products

VII. Metallic Materials and Metal Products

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2554	1. Guard Rail A. Fittings - Splicers, Bolts, etc.	3381	Visual Inspection	Bolts: 2 Post bolts and 4 splice bolts with nuts for each 1,000 units or less.		Form 02415 or 2403 To be approved before use. Materials from H&R may be pre-sampled and tested. Call the MnDOT inspector at 218-846-3613 to see if material has been approved. For non-pre-tested, submit laboratory samples at required rate. For small quantities, lab samples are not required, but document on Form 02415 or 2403 and maintain in project file. Small Quantities: Rail Sections - 20 or less Terminals - 10 or less Post Bolts - 100 or less, Splice Bolts - 100 or less
2554	1.B.i. Non-High Tension Guard Rail Cable	3381	Visual Inspection	1 sample from each spool	1.2 m (4 ft)	Form 02415 or 2403 See VII.1.A.
2554	1. B.ii. High Tension Guard Rail Cable	Special Provisions	Visual Inspection	None, unless material is suspect (see note)	1.2 m (4 ft)	Sample at the rate of 1/50,000 ft. if the strand appears damaged or suspect (Accepted as part of system)
2554	1. Guard Rail C. Structural Plate Beam	3382	Visual Inspection	One sample from one edge of each 200 rail sections or one sample of each 100 terminal sections	Full depth x 0.25 m (full depth x 10")	Form 02415 or 2403 See VII.1.A.
2554	D. Plate Beam Guide Posts	3382	Visual Inspection	None, unless material is suspect		Form 02415 or 2403
2554	E. High Tension Guide Posts	Spec. Provisions	Visual Inspection	None, unless material is suspect		Form 02415 or 2403 (Accepted as part of system)

VII. Metallic Materials and Metal Products (cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2545 2554 2564	2. Steel Sign Posts	3401	Visual Inspection & Certification from Contractor of compliance with Domestic source requirement under 1601, if applicable.	Two posts per shipment of each mass per unit length. Submit shortest full sized length of each weight, not a scrap piece.	See note	Form 02415 or 2403 Check domestic steel requirement under 1601 No Samples for project quantities less than 20
2554 2557	3. Posts for Traffic & Fence A. Steel fence posts, brace bars, and rails	3403 3406	Visual Inspection	One sample per 500 pieces. Submit full length for posts used in the ground (line, terminal, "C" and anchor posts), and 5' length of top rail and brace bar.		Form 02415 or 2403 Check domestic steel requirement under 1601 Special Provision. Retain Certificate of Compliance and certified mill analysis in project file. See link for certification form on right side of page, www.dot.state.mn.us/materials/lab.html
2557	3. Fence B. Components: includes cup, cap, nut, bolt, end clamp, tension band, truss rod tightener, hog ring, tie wire, tension stretcher bar, truss rod, clamp, & tension wire	3376	Visual Inspection	1 each of cup, cap, nut, bolt, end clamp, tension bands, truss rod tightener, 12 hog rings, 6 tie wires, 1 tension stretcher bar, 1 truss rod, cut to 2-foot min. with threaded section, 3 feet of tension wire.		Form 02415 or 2403 Check domestic steel requirement under 1601 Special Provision. Retain Certificate of Compliance in the project file. See link for certification form on right side of page, www.dot.state.mn.us/materials/lab.html
2557	3. Fence C. Gates	3379	Visual Inspection	No sample required. See notes.		Form 02415 or 2403 Check domestic steel requirement under 1601 Special Provision. Retain Certificate of Compliance in the project file. See link for certification form on right side of page, www.dot.state.mn.us/materials/lab.html
2557	3. Fence D. Barbed Wire	3376	Visual Inspection.	One sample per 50 rolls	1 m (3 ft)	Form 02415 or 2403 Check domestic steel requirement under 1601 Special Provision. Retain Certificate of Compliance in the project file. See link for cert. form on right side of page, www.dot.state.mn.us/materials/lab.html

VII. Metallic Materials and Metal Products (cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2557	3. Fence E. Woven Wire Fabric	3376	Visual Inspection	One full height sample per 50 rolls	1 m (3 ft)	Form 02415 or 2403 Check domestic steel requirement under 1601 Special Provision. Retain Certificate of Compliance in the project file. See link for cert. form right side of page, www.dot.state.mn.us/materials/lab.html
2557	3. Fence F. Chain Link Fabric	3376	Visual Inspection	One full height sample for each 5,000 ft of fencing.	0.3 m (1 ft)	Form 02415 or 2403 Check domestic steel requirement under 1601 Special Provision. Retain Certificate of Compliance in the project file. See link for certification form on right side of page, www.dot.state.mn.us/materials/lab.html
2402	4. Water Pipe and other Piping Materials	3364, 3365, 3366 & Special Provisions				Form 02415 or 2403 Check domestic steel requirement under 1601 Special Provision. To be identified & tested if necessary prior to use. See Special Provisions.
2201 2301 2401 2405 2411 2412 2433 2452 2472 2514 2531 2533 2545 2564	5. Reinforcing Steel A. Bars – Uncoated	3301	Visual Check for Size and Grade Marking	No Field Sample Necessary		Form 02415 or 2403 For Uncoated bars - Retain Certificate of Compliance and Certified Mill Analysis in Project File.

VII. Metallic Materials and Metal Products (cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2201 2301 2401 2405 2411 2412 2433 2452 2472 2514 2531 2533 2545 2564	5. Reinforcing Steel B. Bars - Epoxy Coated	3301	Visual Check for Size and Grade Marking and "Inspected" tag	One sample (1 bar) of each size bar for each day's coating production	1 m (3 ft)	Form 02415 or 2403 For Epoxy-Coated bars, steel will be tagged "Inspected" when it has been sampled and tested by MnDOT prior to shipment, and it will be tagged "Sampled" when testing has not been completed prior to shipment. If the Epoxy-Coated bars are not tagged "Sampled" or "Inspected", submit samples with copies of the, Certificate of Compliance, and Certified Mill Analysis. Retain originals of the Certificate of Compliance and Certified Mill Analysis in the project file.
2401	5. Reinforcing Steel C. Bars Stainless Steel	Special Provisions		One sample (2 Bars) per heat per bar size	1 m (3 ft)	Submit copies of mill test reports with samples, retain originals in project file
2401 2411 2452 2472 2564	5. Reinforcing Steel D. Spirals	3305		One per shipment	1 m (3 ft)	Same as 5.B
2201 2301 2401 2411 2412 2472 2531	5. Reinforcing Steel E. Steel Fabric	3303	Visual Inspection	No Field Sample Necessary		Retain Certificate of Compliance in project file.
2201 2301 2401 2411	5. Reinforcing Steel F. Dowel Bars	3302		One Dowel Bar from each shipment	Full Size Dowel Bars	For all types of dowels – Each project shall have a Certificate of Compliance from the Manufacturer certifying that all materials used in fabrication of the dowel bars and baskets comply with all applicable specifications. The Manufacturer shall maintain all records necessary for certification by project. The Certificate of Compliance shall be submitted to the Project Engineer.

VII. Metallic Materials and Metal Products (cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2401 2405	5. Reinforcing Steel G. Prestressing or Post-Tensioning Strand	3348		One sample (2 strands) from each heat (see Notes)	1.8 m (6 ft)	Submit one copy of mill certificate and one copy of the stress-strain curve representative of the lot with the samples. For most manufacturers, a heat equals a production lot, and an individual lot, pack, or reel is a subset of a heat/production lot.
2402 2506 2565	6. Drainage and Electrical Castings	3321 2471 2565	Visual Inspection	All castings: Three tensile bars to be cast with each heat at Foundry and submitted to the lab by an approved Foundry*. See 3321.		Form 02415 or 2403 Call Maplewood Laboratory at 651-366-5540 for list of approved foundries, or see website. Inspect in the field and retain Form 02415 or 2403 in project file, showing name of foundry and quantity
2401 2402 2411 2433 2545 2554 2564 2565	7. Anchor Rods (Cast in Place)	3385 3391 3392	Check Approved/Qualified Products list, mill certifications, and visual inspection at the project site.	Pre-approved (see notes) or one complete anchor rod assembly including nuts and washers from each lot supplied.		Pre-approved system requires supplier to submit a sample to the Department yearly for each anchor rod grade. Test results of sample must verify compliance to product specifications.
2401 2402 2411 2433 2545 2554 2564 2565	8. Structural Fasteners, both coated and uncoated	3385 3391 3392	Visual inspection and verify material is on APL/QPL, or submit sample for verification testing if not on APL/QPL	Pre-approved (see notes) or two complete assemblies for each size, length, diameter, grade and finish, per increment of 1000 or fraction thereof		Pre-approved system requires the supplier to submit a sample yearly for each fastener size, grade and finish. Test results must verify compliance to specifications. If not on the APL/QPL, submit two complete assemblies for each size, length, grade and finish per increment of 1000 or fraction thereof of fasteners supplied for the project, including nuts and washers from each lot supplied. Obtain passing test results before installation.
2401 2411 2433	9. Anchorages (Drilled In)	Special Provisions	Visual Inspection	No laboratory samples required		Note: Before installation, verify that anchorages are on the qualified products list www.dot.state.mn.us/products

VII. Metallic Materials and Metal Products (cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2402	10. Structural Steel A. For Steel Bridge -- Beams, Girders, Diaphragms, etc.	2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/
2402 2405	10. Structural Steel B. For Concrete Girders- Diaphragms and sole plates	2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/
2402	10. Structural Steel C.. Expansion joints	2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/
2402	10. Structural Steel D. Steel Bearings	2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/

VII. Metallic Materials and Metal Products (cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2402	10. Structural Steel E. Railing-Structural tube and ornamental	2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/
2402	10. Structural Steel F. Drainage Systems	2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/
2402	10. Structural Steel G. Protection Angles	2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/

VII. Metallic Materials and Metal Products (cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2564	11. Overhead Sign structures	2564 2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/
2545	12. High Mast Lighting Structures	2545 2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/
2565	13. Monotube Signal Structures	2565 2471	Structural Metals Inspection Tag and field inspection for damage/defects	None		Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2403 2422 2452 2521 2540 2545 2554 2557 2564	1. Timber, Lumber Piling & Posts	3412 to 3471 & 3491	Visual Inspection			Form 02415 or 2403 Untreated materials shall be inspected in the field and the results reported on Form 02415 or 2403. Treated materials shall be Certified on the Invoice or Shipping Ticket. Material is inspected and stamped by an Independent Agency as per Specification 3491. Contact Laboratory for additional information.
2402 2405 2557 Many	2. Miscellaneous pieces and Hardware (Galvanized)	3392 3394		3 samples of each item per shipment. Sample critical items only. (Critical items are load bearing, structurally necessary items.)	Three of each type.	Form 02415 or 2403 Will carry "Inspected" tag if sampled and tested prior to shipment. No sample necessary if "Inspected".
2504	3. Insulation Board	3760	Visual Inspection	None		Form 02415 or 2403
2402	4. Laminated Elastomeric Bearing Pads	3741 and Special Provisions	Structural Metals Inspection Tag and field inspection for damage/defects	See Notes		See Project Special Provisions for Sampling, Testing, and Acceptance Requirements.
2402	4. Plain Elastomeric Bearing Pads	3741 and Special Provisions	Structural Metals Inspection Tag and field inspection for damage/defects	See Notes		See Project Special Provisions for Sampling, Testing, and Acceptance Requirements.
2402	4. Cotton Duck Bearing Pads	3741 and Special Provisions	Structural Metals Inspection Tag and field inspection for damage/defects	See Notes		See Project Special Provisions for Sampling, Testing, and Acceptance Requirements.

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2402 2422 2501 2503 2506	1. Corrugated Metal Products A. Culvert Pipe Underdrains Erosion control Structures	3225 thru 3229, 3351 and 3399	Visual Inspection: Check for good construction, finish workmanship, finish requirements and shipping			Form 02415 or 2403 Make certain pipe is Certified on Invoice, retain certificate of compliance and certified mill analysis in project file
2501	1. Corrugated Metal Products B. Structural Plate	3231	Visual Inspection: Invoice shall include notation that material described is in accordance with fabricator's Certificate and Guarantee			Same as 1.A
2501	1. Corrugated Metal Products C. Aluminum Structural Plate	3233				Retain certificate of compliance and certified mill analysis in project file
2503 2506	2. Clay Pipe	3251	No samples required for less than 100 pieces	1 sample per 200 pieces of each size.	Full Size Pipe	Form 02415 or 2403
2501 2503 2506	3. Concrete Pipe A. Reinforced Pipe and Arches, Precast Cattle Pass Units, and Sectional Manhole Units	3236	Field Inspection: Check for damage and defects. Check dimensions as required. Check for producer's "Certified" stamp and signature on the certification document.	1 "companion" cylinder per month per plant during production, or cylinder testing machine, whichever is greater. Call Precast Inspection Engineer at 651-366-5540 for additional information.		Form 02415 or 2403 For Concrete Pipe Both A & B: Product will be certified by producer, only spot checks are done by plant inspector. Make certain the invoice or certification document is signed and the product has the required markings. Maintain Form 2403 or 02415 in project records, showing source of materials and type and quantity used
2501 2503 2506	3. Concrete Pipe Fine Aggregate	3126		1 quality test per month during production for A and B above.	10 kg. (25 lb.)	
2501 2503 2506	3. Concrete Pipe Coarse Aggregate	3137		1 quality test per month during production for A and B above.	10 kg. (25 lb.)	

IX. Geosynthetics, Pipe, Tile, and Precast/Prestressed Concrete (Cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2412	4. Precast/Prestressed Concrete Structures A. Reinforced Precast Box Culvert	3238	1 air test per pour (1st load), One set of cylinders per 25 cubic yards, with a minimum of two cylinders per set. Alternate cylinder acceptance systems may be allowed with the approval of the State Materials Engineer.	1 "companion" cylinder per month per plant during production, or cylinder testing machine, whichever is greater. Call Precast Inspection Engineer at 651-366-5540 for additional information.		Precast/prestressed Concrete Structure (beams, posts, etc.) will be inspected and stamped at plant. Field personnel are responsible for checking for plant inspector's stamp, for shipping/handling damage or defects, and dimensions. An inspection report will be completed by plant personnel and sent to the field personnel.
	Fine Aggregate	3126		1 quality test per month during production.	10 kg. (25 lb.)	
	Coarse Aggregate	3137		1 quality test per month during production.	10 kg. (25 lb.)	
2405	4. Precast/Prestressed Concrete Structures B. Precast/Prestressed Concrete Structure (beams, posts, etc.).	2405	1 air test per pour (1st load), One set of cylinders per 25 cubic yards, with a minimum of two cylinders per set, and one set per beam. Alternate cylinder acceptance systems may be allowed with the approval of the State Materials Engineer.	1 "companion" cylinder per month per plant during production, or cylinder testing machine, whichever is greater. Call Precast Inspection Engineer at 651-366-5540 for additional information.		Precast/prestressed Concrete Structure (beams, posts, etc.) will be inspected and stamped at plant. Field personnel are responsible for checking for plant inspector's stamp, for shipping/handling damage or defects, and dimensions. An inspection report will be completed by plant personnel and sent to the field personnel.
	Fine Aggregate	3126	Gradation: 1 per 150 m ³ (200 Cu. yd.) or fraction thereof. 1 per day of production or 3 per week, whichever is less.	1 gradation and 1 quality test per month during production from a split sample. Include producer's gradation results on sample card.	10 kg (25 lb.)	
	Coarse Aggregate	3137	Gradation: 1 per 75 m ³ (100 Cu yd) or fraction thereof. 1 per day of production or 3 per week, whichever is less.	1 gradation and 1 quality test per month during production from a split sample. Include producer's gradation results on sample card.	10 kg (25 lb.)	

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2506	5. Manholes and Catch Basins (Construction)	2506 3622	Field Inspection: Check for damage and defects. Check dimensions as required. Check for Producer's "Certified" stamp and signature on the certification document.	1 "companion" cylinder per month per plant during production, or cylinder testing machine, whichever is greater. Call Precast Inspection Engineer at 651-366-5540 for additional information.		Form 02415 or 2403 Product will be certified by producer or inspected, tested and stamped at source. Only spot checks are done by plant inspector. Make certain the invoice or certification document is signed and the product has the required markings. Maintain Form 2403 or 02415 in project records, showing source of materials and type and quantity used (bricks, blocks, precast, or combination).
2502	6. Drain Tile (Clay or Concrete)	3276	Visual Inspection	2 samples of each size from each source		
2502 2503	7. Thermoplastic (TP) Pipe ABS and PVC	3245	Obtain Certificate of compliance. Check for approved marking printed on pipe. Field Inspect for damage or defects.			Form 02415 or 2403 See Spec. 3245 for specific AASHTO or ASTM Pipe types are approved under this specification. If perforated, holes should be 5mm - 10 mm (3/16 - 3/8 inch) diameter, two rows for 4", and four rows for 6" diameter; approximately 75 mm (3 inches) on center.
2502	8. Corrugated Polyethylene Pipe - Single wall for edge drains, etc.	3278	Check for markings (AASHTO M 252) Certificate of Compliance. Field Inspect for damage or defects.	No Laboratory tests required		Form 02415 or 2403
2503	9. Sewer Joint Sealing Compound	3724		One per shipment	0.5 liter (1 pt.)	
2412 2501 2503	10. Preformed Plastic Sealer for Pipe	3726 Type b		One from each source	0.3 m (1 ft)	
2412 2501 2503	11. Bituminous Mastic Joint Sealer for Pipe	3728	Visual Inspection	Sample, if questionable		

IX. Geosynthetics, Pipe, Tile, and Precast/Prestressed Concrete (Cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2105	12. EPS Geofoam	Special Provisions	Visual Inspection Check for yellow aged material, uniformity and dimensions. Weigh 1'x1'x1' cut coupon to verify density every 200 m ³ (250 yd ³)			Form 02415 or 2403
2501 2503	13. Corrugated Polyethylene Pipe – Dual Wall, 12" – 48"	3247				For Specification 3247, Corrugated Polyethylene Pipe (HDPE) manufacturing facilities are required to be reviewed <u>yearly</u> and in compliance with AASHTO's National Transportation Product Evaluation Program (NTPEP) for producers of AASHTO M294 HDPE pipe. To determine if a pipe manufacturing plant is qualified, click on the following link for M294 pipe. http://data.ntpep.org/Module/PIPE/StatusReport.aspx If a plant has a compliant NTPEP audit for AASHTO M294 pipe at the time the pipe is manufactured, then the plant has met requirements. Note that a previous year's audit shall govern until NTPEP issues the next year's audit. A Certificate of Compliance shall be provided in accordance with Specification 1603.

IX. Geosynthetics, Pipe, Tile, and Precast/Prestressed Concrete (Cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2105 2411 2412 2501 2502 2511 2512	14. Geotextile Fabric and Geogrid Reinforcement	3733 and Special Provisions	Inspect for damage and uniformity of texture. Rolls of both geotextile and geotextile wrapped PE Tubing must be wrapped in UV protective plastic. (Usually Black). Obtain Certificate of Compliance If using adhesive for seams, see Approved/Qualified Product List available at the Department's website	(a) 1 per project for pipe wrap or trench lining for Permeable base designs. (b) 1 per 50,000 yd ² (40,000 m ²) or fraction thereof of each type fabric or geogrid for all other uses. (c) Seam, if required, 1 per project minimum, additional as appropriate. Small Quantity Acceptance <ul style="list-style-type: none"> For fabric totals less than 200 yd² (170 m²) For pipe wrap totals less than 1000 Lin. Ft No sampling required Use Inspection Report for Small Quantities (Form 2403) Check: <ul style="list-style-type: none"> Certificate of Compliance Identifying label on product Geotextile Small Quantity Acceptance List at http://www.dot.state.mn.us/materials/aggregatedocs/gtxlist.pdf 	(a) 10 Lin. Ft. (3 m) (b) 4 yd ² (3 m ²)* (c) 10 Lin. Ft. (3 m)**	Certificate of Compliance shall state material identification (e.g. Propex 2002, Miragrid 8XT), and minimum average roll values (MARV) for all specified geotextile properties. MARV values must meet the Specification 3733 Types 1 through 7 requirements for the specific application. Submit copy of Certificate with material samples sent to the Materials Laboratory. Submit additional sample(s), if the manufacturer or model of geotextile or geogrid used changes during construction. Sampling shall be by random selection and no more than one sample shall be taken from an individual roll. For type 6 applications (including geogrids), submit pages of Special Provisions that list required material properties. (Type 6 requirements are job specific.) For Modular Block Walls or Reinforced Soil Slopes, submit page(s) of shop drawings that reference geogrid/geotextile to be used (product name) and/or required properties. * Do not sample first full turn of rolled product. ** Seam sample to include approximately 3 ft (1 m) of geosynthetic material on each side of seam (in direction perpendicular to seam).

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2506	1. Brick A. Sewer (clay) and Building	3612 to 3615	Visual Inspection	One sample per 50,000 brick or fraction thereof	6 whole bricks	
2506	1. Brick B. Sewer (Concrete)*	3616	Visual Inspection	One sample per shipment.	6 whole bricks	* Air entrainment required. Obtain air content statement from supplier.
2506	2. Concrete Masonry Units A. For Sewer Construction	3621	Visual Inspection	One sample per shipment	6 whole units	Air entrainment required. Obtain air content statement from supplier.
2411	2. Concrete Masonry Units B. For Modular Block Retaining Walls	Special Provisions	Visual Inspection Check for cracks and broken corners	One sample per 10,000 units or fraction thereof, with a minimum of one sample per product (block) type per contract.*	5 whole units	All lots of block upon delivery shall have Manufacturer or Independent laboratory test results to verify passing both compression and freeze-thaw requirements. * Wall units and cap units are considered separate block types.
2422	3. Reinforced Concrete Cribbing	3661	Concrete control tests Air Tests Visual Inspection if previously tested	One cylinder per 100 units, but not less than 5 cylinders for a given contract. Other materials as required herein.	150 x 300mm (6 x 12 in) Cylinders	Form 02415 or 2403 Will be stamped when inspected prior to shipment.
2511 2512 2577	4. Stone for Masonry or Rip-Rap	3601 and Special Provisions	Visual Inspection Submit Form 02415 unless special testing is specified			Form 02415 or 2403 Each source shall be approved by Project Engineer or Supervisor for quality, prior to use. For questions on quality, contact District Materials or Geology Unit.

XI. Electrical and Signal Equipment Items

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2545	1. Lighting Standards (Aluminum or Steel)	3811	Visual Inspection			The Fabricator shall submit "Certificate of Compliance", on a per project basis, to the Project Engineer..
2545 2550 2565	2. Hand Holes (Precast, PVC, and LLDPE)	2545 2550 2565				Form 02415 or 2403 Traffic signals and street lighting projects require handholes and frames and covers to be listed on the MnDOT Approved/Qualified Products List (A/QPL) for signal. For cast iron frame and cover: see VII.6, Drainage Castings
2545 2565	3. Foundation	2545	Slump as needed	1 cylinder per 20 m ³ (25 Cu. yd.)		Rebar is required in concrete foundations as specified in the Contract documents for all traffic signal and street lighting projects.
2402 2545 2565	4. Conduit and Fittings A. Metallic	3801 3802	Visual Inspection	None		Form 02415 or 2403 Conduit shall be labeled as being listed by a National Recognized Testing Laboratory (NRTL). Retain Form 02415 or 2403 in Project File
2545 2565	4. Conduit and Fittings B. Non-Metallic (Rigid and HDPE)	3803 Special Provisions	Visual Inspection			Form 02415 or 2403 Conduit shall be labeled as being listed by a National Recognized Testing Laboratory (NRTL). Retain Form 02415 or 2403 in Project File. For traffic signal and street lighting projects, specific requirements are contained in the Special Provisions for each project.
2545 2565	5a. Anchor bolts (cast in place)	2545 2565				See section VII, 7.
2545	5b. Anchorages (Drilled In)	2545				See section VII, 8.

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2545 2565	6. Miscellaneous Hardware	2545 2565	Visual Inspection	Sample critical items only. One of each item per shipment. (Critical Items are load bearing, structurally necessary items.)		Will carry "Inspected" tag if sampled and tested prior to shipment. No sample necessary if "Inspected". Do not use if not tested. Field sample at sampling rate for laboratory testing. For traffic signal and street light lighting projects, various miscellaneous hardware is required to be listed on the MnDOT Signals and Lighting Approved/Qualified Products Lists (A/QPL). The Contract documents indicate which items must be on the Signals and/or Lighting APL.
2545 2550 2565	7. Cable and Conductors A. Power Conductors Loop Detector Conductors (No Tubing) Underground Service Entrance (USE) cables	3815.2B1 3815.2B2(a) Special Provisions	Visual Inspection	None		Form 02415 or 2403 Make certain the conductors are the type specified. Submit Field Inspection report showing type and quantities used. Shall be labeled as being listed by a National Recognized Testing Laboratory (NRTL) and type where applicable.
2545 2550 2565	7. Cable and Conductors B. Electrical Cables and Single Conductors with Jacket	3815.2B2(b) 3815.2B3 3815.2B5 3815.2C1 3815.2C3 3815.2C4 3815.2C5 3815.2C6 3815.2C7 3815.2C8 3815.2C14 Special Provisions	Visual Inspection	1 sample per size per lot	1.5m (5 ft)	Form 02415 or 2403 Usually inspected at the distributor. Documentation showing project number, reel number(s), & MnDOT test number(s) will be included with each project shipment. If such documentation is not received from Contractor, submit sample for testing along with material certification from manufacturer. <u>Do not</u> use if <u>not</u> tested. Pre-inspected materials will <u>not</u> be tagged; an inspection report will be sent by the MnDOT inspector for each shipment. Project inspectors should verify that the shipping documents agree with this inspection report. Call Steve Grover at 651-366-5540 or Cindy Schellack at 651-366-5543 with questions. For traffic signal and street lighting projects, the Special Provisions for each project contain electrical cable and conductor specifications.
2545 2550 2565	7. Cable and Conductors C. Fiber Optic Cables	3815.2C13	Visual Inspection - verify make and model number as shown in Special Provisions	None		Form 02415 or 2403 Fiber optic cables shall be listed on the MnDOT Approved/Qualified Products List (A/QPL) for Traffic Management Systems/ITS.

XI. Electrical and Signal Equipment Items (cont.)

Pay Item No.	Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)	Minimum Required Sampling Rate for Laboratory Testing	Sample Size	Notes
2545 2565	8. Ground Rods	2545 2565	Visual Inspection	None.		Form 02415 or 2403 Retain Form 02415 or 2403 in project file. Shall be labeled as being listed by a National Recognized Testing Laboratory (NRTL).
2545	9. Luminaires and Lamps	3810				Form 02415 or 2403 Traffic signal and street lighting projects require luminaires and lamps to be listed on the MnDOT Approved/Qualified Products List (A/QPL) for Lighting. The conductors shall be labeled as being listed by a National Recognized Testing Laboratory (NRTL) and type, where applicable.
2545	10. Electrical Systems					Electrical Systems are to be reported as a "System" using the Lighting, Signal, and Traffic Recorder Inspection Report. To be certified by the Project Engineer.
2565	11. Traffic Signal Systems	2565				Traffic Signal Systems are to be reported as a "System" using the Lighting, Signal, and Traffic Recorder Inspection Report. To be certified by the Project Engineer.

(2301) CONCRETE PAVEMENT (2013 VERSION)

MnDOT 2301 shall be deleted and replaced with the following:

2301.1 DESCRIPTION

This work consists of constructing portland cement concrete pavement on a prepared base.

The Department defines paving concrete to include concrete mainline, ramps, loops, integrant curb, shoulders, and curb and gutter placed adjacent to the concrete mainline with the same mixture used in the paving. Integrant curb is a curb constructed monolithically with the pavement.

For the purposes of concrete pavement, the Department defines a concrete plant as the following:

- (1) A paving plant using dump or agitator trucks to haul concrete, or
- (2) A certified ready-mix plant using truck mixers to haul concrete.

For concrete pavement incentives and disincentives, the Department defines a concrete plant as the following:

- (1) A primary concrete plant providing the majority of the concrete to a paving project, and
- (2) A secondary concrete plant providing any minor work or fill-ins not provided by the primary concrete plant.

Only one primary concrete plant per project is allowed unless otherwise approved by the Engineer. The Contractor may use a paving plant or a certified ready-mix plant as the primary concrete plant.

2301.2 MATERIALS

A Concrete2461

A.1 Slipform Placement Mix No. 3A21

A.2 Fixed Form Placement Mix No. 3A41

B Coarse and Fine Aggregate Requirements

Test each aggregate fraction proposed for use in accordance with Table 2301-1:



Table 2301-1	
Aggregate Testing Requirements	
Aggregate	Testing Required
Tested by Department in the last 3 years	No additional testing *
Not tested by the Department in the last 3 years	Preliminary aggregate testing in accordance with 2301.2.B.1, "Required Preliminary Aggregate Testing."
New source	New source concrete aggregate testing in accordance with 3126, "Fine Aggregate for Portland Cement Concrete," and 3137, "Coarse Aggregate for Portland Cement Concrete."
* Perform additional testing as required by the Engineer in conjunction with the Concrete Engineer.	

B.1 Required Preliminary Aggregate Testing

After the Department awards the Contract and as soon as coarse and fine aggregates are available for testing, contact the Engineer to coordinate preliminary sampling of aggregate for concrete paving. The Engineer, in conjunction with the Concrete Engineer, will sample and test the aggregate to verify specific gravity, absorption data, and aggregate quality. The Department will perform other tests as determined necessary by the Engineer, in conjunction with the Concrete Engineer.

B.2 Aggregate Alkali Silica Reactivity (ASR) Requirements for Concrete Mixes

The Department will test the designated fine aggregate for alkali silica reactivity (ASR) with Holcim, St. Genevieve, Type I/II portland cement and Lafarge, Davenport, Type I/II portland cement in accordance with ASTM C 1260 MnDOT Modified. If the fine aggregate contains an intermediate size aggregate such as "buckshot" or "pea rock" as determined by the Concrete Engineer, the Department will perform testing in accordance with ASTM C 1260.

The Concrete Engineer, in conjunction with the Engineer, will review the 14-day fine aggregate expansion test results to determine the acceptability of the proposed fine aggregate and cement combination in accordance with the 14-day fine aggregate expansion limits in Table 2301-2:

Table 2301-2	
Fine Aggregate ASR Mitigation Requirements	
14-day Fine Aggregate Expansion Limits	Mitigation Requirement
≤ 0.150	The Department will accept the fine aggregate with or without a mitigator
$> 0.150 - 0.250$	Mitigate the fine aggregate with 35 percent slag or at least 20 percent fly ash
$> 0.250 - 0.300$	Mitigate the fine aggregate with 35 percent slag or 30 percent fly ash in accordance with 3115, "Fly Ash for Use in Portland Cement Concrete," modified with at least 66.0 percent $\text{SiO}_2 + \text{Fe}_2\text{O}_3 + \text{Al}_2\text{O}_3$ on a dry weight basis and at least 38.0 percent SiO_2
> 0.300	The Department will reject the fine aggregate

For fine aggregate and cement combinations previously tested by the Department, the Concrete Engineer will use the previous test results to determine necessary mitigation. The Contractor may contact the Department to access the list of previously tested fine aggregate sources.

If the fine aggregate and cement combination were not previously tested, the Concrete Engineer will use the higher expansion result of the two fine aggregate and cement combinations to determine necessary mitigation.

Add "buckshot" or "pea rock" as a separate aggregate in accordance with the quality requirements of 3137, "Coarse Aggregate for Portland Cement Concrete," except the Department will determine the shale content in accordance with AASHTO T 113 MnDOT Modified, "Lightweight Pieces in Aggregate," fine aggregate procedure. If this aggregate is from the same source as the $\frac{3}{4}$ in+ [19 mm+] or $\frac{3}{4}$ in- [19 mm-] aggregate, the Concrete Engineer will waive the requirements specified in 3137.2.D.3(b), "Carbonate in Class C Aggregate by Weight. If this aggregate is from sources other than the $\frac{3}{4}$ in+ [19 mm+] or $\frac{3}{4}$ in- [19 mm-] aggregate, approval is at the discretion of the Concrete Engineer.

The Concrete Engineer may reject the fine aggregate if mortar bar specimens exhibit an indication of external or internal distress not represented by the expansion results. The Concrete Engineer will make the final acceptance of the aggregate.

C Cementitious Materials

Design the concrete paving mixes in accordance with the following requirements for cementitious material:

- (1) Total alkalis no greater than 0.60 percent in the portland cement ($\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O}$)
- (2) Total alkalis no greater than 5.0 lb per cu. yd [3.0 kg per cu.m] in the combined cementitious material
- (3) At least 530 lb per cu. yd [315 kg per cu. m] minimum cementitious,
- (4) At least 400 lb per cu. yd [237 kg per cu. m] of portland cement when using fly ash or at least 385 lb per cu. yd [228 kg per cu. m] when using slag as a portland cement replacement,
- (5) Provide additional cementitious material to meet requirements in accordance with this section at no additional cost to the Department,
- (6) Total cementitious material no greater than 600 lb per cu. yd [356 kg per cu. m] except for high-early strength mixes.
- (7) Maximum of 33 percent substitution of Class C or Class F Fly Ash for concrete pavement, on a one for one basis, by weight of the designed portland cement;
- (8) Maximum of 35 percent substitution of slag, on a one for one basis, by weight of the designed portland cement; and
- (9) Ternary mixes (portland cement and two other supplementary cementitious materials) are allowed when approved by the Engineer, in conjunction with the Concrete Engineer, or required by or allowed in the Contract.

The Department defines high-early strength concrete as concrete with a cementitious content of greater than 600 lb per cu. yd [356 kg per cu. m].



The Contractor may use 100 percent portland cement for the cementitious material for high-early mixes, except if using quartzite or gneiss coarse aggregate provide high-early mixes in accordance with 2301.2.C.1, "Special Cementitious Requirements for Quartzite and Gneiss."

C.1 Special Cementitious Requirements for Quartzite and Gneiss

If providing coarse aggregate from sources identified by the Department as quartzite or gneiss and if the coarse aggregate does not meet the 0.04 percent expansion limit when tested in accordance with ASTM C 1293, replace the portland cement with the following:

- (1) 30 % of a fly ash from the Approved/Qualified Products List in accordance with 3115, "Fly Ash for Use in Portland Cement Concrete," except provide fly ash in the concrete mixture with at least 66 percent $\text{SiO}_2 + \text{Fe}_2\text{O}_3 + \text{Al}_2\text{O}_3$ on a dry weight basis for at least 12 consecutive months and at least 38 percent SiO_2 content, or
- (2) 35 % of a ground granulated blast furnace slag from the Approved/Qualified Products List.

D Concrete Mix Design Requirements

Design the concrete mix based on an absolute volume of 27 cu. ft \pm 0.10 cu. ft [1.000 cu. m \pm 0.003 cu. m] in accordance with the following:

- (1) Fine aggregates complying with the requirements of 3126, "Fine Aggregate for Portland Cement Concrete," for aggregate quality,
- (2) Coarse aggregates complying with the requirements of 3137, Coarse Aggregate for Portland Cement Concrete," for aggregate quality,
- (3) Air content of 7.0 percent \pm 1.5 percent at the point of placement, and
- (4) High-early concrete placed at a water-cementitious ratio not greater than 0.38.

Submit the concrete mixes using the MnDOT Contractor Mix Design Submittal Worksheet available on the Department's website at least 21 calendar days before the initial placement of concrete using the concrete mix design. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal and approve the materials and mix design for compliance with the Contract.

The Contractor assumes full responsibility for the mix design and performance of the concrete.

The Engineer determines final acceptance of concrete for payment based on satisfactory field placement and performance.

D.1 Concrete Pavement < 3,500 cu. yd [2,900 cu. m]

If the estimated quantity of concrete pavement in the Contract is less than 3,500 cu. yd [2,900 cu. m], calculated by multiplying the planned pavement area by the planned pavement thickness, provide a mix design meeting the following requirements:

- (1) Grade A paving concrete placed at a water/cement ratio no greater than 0.42;

- (2) Fine aggregates with a gradation in accordance with Table 3126-3, "Fine Aggregate Gradation Requirements;"
- (3) CA-15, CA-35, or CA-50 coarse aggregates with a gradation in accordance with Table 3137-4, "Coarse Aggregate Designation for Concrete;"
- (4) Instead of item (2) and (3) of this list, provide a Job Mix Formula in accordance with 2301.2.D.3, "Job Mix Formula;" and
- (5) The incentive/disincentives for aggregate quality, well-graded aggregate, and water/cement ratio as specified in 2301.2.D.4, "Concrete Pavement Incentives and Disincentives," shall not apply.

D.2 Concrete Pavement \geq 3,500 cu. yd [2,900 cu. m]

If the estimated quantity of concrete pavement in the Contract is equal to or greater than 3,500 cu. yd [2,900 cu. m], calculated by multiplying the planned pavement area by the planned pavement thickness, provide a mix design meeting the following requirements:

- (1) Grade A paving concrete placed at a water/cement ratio no greater than 0.40;
- (2) Submit a Job Mix Formula in accordance with 2301.2.D.3, "Job Mix Formula;"
- (3) For concrete produced at a secondary concrete plant or as otherwise allowed by the Engineer, the Contractor has the option to design a mix in accordance with 2301.2.D.1, "Concrete Pavement $<$ 3,500 cu. yd [2,900 cu. m];" and
- (4) The incentive/disincentives for aggregate quality, well-graded aggregate, and water/cement ratio as specified in 2301.2.D.4, "Concrete Pavement Incentives and Disincentives," shall apply to the primary concrete plant only,

D.3 Job Mix Formula

Use at least two fractions of coarse aggregate that include the $\frac{3}{4}$ in+ [19 mm+] and $\frac{3}{4}$ in- [19 mm-] fractions.

A Job Mix Formula (JMF) contains proportions of materials and individual gradations of each material plus a composite gradation. The Engineer will base the JMF on the combination of coarse and fine aggregate in accordance with Table 2301-3. The Department will waive the gradation requirements of 3126, "Fine Aggregate for Portland Cement Concrete," and 3137, "Coarse Aggregate for Portland Cement Concrete."

Table 2301-3 Job Mix Formula Working Range	
Sieve Sizes	Working Range, %*
2 in [50 mm]	± 5
1½ in [37.5 mm]	± 5
1 in [25 mm]	± 5
$\frac{3}{4}$ in [19 mm]	± 5
$\frac{1}{2}$ in [12.5 mm]	± 5
$\frac{3}{8}$ in [9.5 mm]	± 5
No.4 [4.75 mm]	± 5
No.8 [2.36 mm]	± 4
No.16 [1.18 mm]	± 4
No.30 [600 μ m]	± 4
No.50 [300 μ m]	± 3
No.100 [150 μ m]	± 2



No.200 [75 μ m]	≤ 1.6
* Working range limits of the composite gradation based on a moving average of 4 tests (N=4).	

Add fill-in sieves as needed during the testing process to prevent overloading. Provide combined aggregates with 100 percent passing the 2 in [50 mm] sieve and no greater than 1.6 percent passing the No. 200 [75 μ m] sieve. In addition, each coarse aggregate fraction must comply with the Material Passing the No. 200 [75 μ m] sieve requirement in row (i) of Table 3137-1.

Include working ranges based on the composite gradation of the sieves specified in Table 2301-3 with the JMF submittal.

Take samples at the belt leading to the weigh hopper or other locations close to the incorporation of the work as approved by the Engineer. The Engineer will determine the sampling location by using a random number chart and multiplying the random number by the sampling rate as defined in the Schedule of Materials Control. Test, and record the individual results.

The Engineer will randomly verify Contractor combined aggregate gradation results as defined in the Schedule of Materials Control.

If the quantities of concrete produced results in no gradation testing for any given day, include the untested quantity of concrete into the next day's production and include that quantity of concrete in the sampling rate. If the untested quantity is on the last day of production, add that quantity to the previous day's production.

D.3.a JMF Adjustments

If, during production, the moving average of QC aggregate gradation tests falls outside the allowable JMF working range, make adjustments within the limits specified in Table 2301-4 without submitting a new mix design as approved by the Engineer.

Table 2301-4	
Allowable JMF Adjustments	
Sieve Size	Allowable Adjustment, %
\geq No. 4 [4.75 mm]	± 5
No. 8 [2.36 mm] – No.30 [600 μ m]	± 4
No. 50 [300 μ m]	± 3
No. 100 [150 μ m]	± 2

The Contractor may continue paving after submitting a new JMF with working range and aggregate volume adjustments to the Engineer. Submit all JMF adjustments on the MnDOT JMF Adjustments Worksheet available from the Department's website.

If the moving average of four tests falls outside of the adjusted allowable working range, stop production and provide a new mix design including JMF as directed by the Engineer, in conjunction with the Concrete Engineer.

D.4 Concrete Pavement Incentives and Disincentives

The Department will apply concrete mix incentives or disincentives for contracts using at least 3,500 cu. yd [2,900 cu. m] of concrete, calculated by multiplying the planned pavement area by the planned pavement thickness, of paving concrete.

The Department will only apply incentives or disincentives for materials provided or produced by the Contractor's primary concrete plant.

The Department will not provide water/cement ratio incentive payments for high-early mixes. The Department will only apply water/cement incentives or disincentives for concrete hauled in dump trucks, agitator trucks, or both.

If the Contractor adds water to the pavement surface without approval by the Engineer, the Department will not pay water/cement or ride incentives on sections where the water is added and the Engineer may reject the pavement in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

D.4.a Coarse Aggregate Quality Incentive/Disincentive

The Engineer will accept the coarse aggregate for paving concrete by statistical methods and in accordance with all other aggregate quality requirements of 2301, "Concrete Pavement," 2461, "Structural Concrete," and 3137, "Coarse Aggregate for Portland Cement Concrete."

The Coarse Aggregate Quality Incentive/Disincentive for CLASS B and CLASS C Aggregates will comply with the following:

The Engineer will take samples at the belt leading to the weigh hopper or other locations close to the incorporation of the work as determined by the Engineer. The Engineer will take samples in accordance with Table 2301-5:

Table 2301-5	
Coarse Aggregate Quality Incentive/Disincentive Sampling Rates	
Plan Concrete, cu. yd [cu. m]	Samples per Fraction (n)
3,500 – 7,500 [2,900 – 6,250]	3
7,501 – 10,000 [6,251 – 8,500]	5
10,001 – 25,000 [8,501 – 21,000]	10
25,001 – 50,000 [21,001 – 42,000]	15
> 50,000 [42,000]	20

The Engineer will consider the entire project as a single lot for each of the two fractions containing the highest percentage by weight. If the project is planned for construction over multiple years and before placing any concrete pavement, request that the Engineer calculate the incentive/disincentive payment on a yearly basis. The Engineer, in conjunction with the Concrete Engineer, will modify the sampling and testing rates as necessary.

The Engineer will establish a new statistical family for each change in aggregate source, fraction, or both.

The Engineer will randomly choose the acceptance samples.

The Engineer will divide a lot representing the plan cubic yards [cubic meters] of concrete by the number of samples to form sublots. The Engineer will multiply the number of cubic yards [cubic meters]



in a subplot by a random number to obtain the position in the subplot for the sample. The Engineer will split the samples and leave half of the sample for the Contractor. The Engineer's laboratory will test the samples and report the individual results. The Engineer will calculate a Quality Index (QI) for each fraction in accordance with the following:

$$QI = X + k(s)$$

Where:

$$X = \text{mean} = \sum \frac{X_i}{n}$$

X_i = individual test results

$$s = \text{standard deviation} = \sqrt{\sum \frac{(x_i - x)^2}{(n-1)}}$$

k = Adjustment Factor based on the number of tests as shown in Table 2301-6:

Table 2301-6	
Adjustment Factor "k"	
k	No. of Tests
1.09	3
1.20	4
1.23	5
1.26	10
1.27	≥ 15

If Class A, Class B, and Class C aggregates meet the requirements as determined by the Engineer, the Department will provide payment based on a per fraction incentive in accordance with Table 2301-7.

Table 2301-7		
Coarse Aggregate Quality Incentive/Disincentive		
Aggregate Class	QI for Fraction, %	Structural Concrete per cu. yd [cu. m] Payment Change per Fraction
Class A (including quartzite and gneiss)	—	\$1.00 [\$1.30]
Class B (based on % absorption)	≤1.00	\$1.00 [\$1.30]
	1.01 – 1.45	\$0.50 [\$0.65]
	1.46 – 1.76	\$0.00
	1.77 – 1.85	–\$1.00 [\$1.30]
	≥ 1.86	As recommended by the Concrete Engineer, with coordination of the Engineer
Class C (based on % carbonate)	≤ 15.0	\$1.00 [\$1.30]
	15.1 – 24.0	\$0.50 [\$0.65]
	24.1 – 31.0	\$0.00
	31.1 – 35.0	–\$1.00 [\$1.30]
	≥ 35.1	As recommended by the Concrete Engineer, with coordination of the Engineer

The Department will not pay incentives or disincentives for Class R aggregates.

If the concrete mixture contains at least three fractions of coarse aggregate, the Engineer will consider only the two containing the highest percentage by weight as eligible for incentive. The Contractor may combine at least two sub-fractions to form the $\frac{3}{4}$ in – [19 mm –] fraction for either the coarse or fine fraction of the coarse aggregate. Blend the sub-fractions by weight. The Engineer will base the maximum incentive for aggregate quality on the two largest fractions by weight.

The Department will pay for Coarse Aggregate Quality Incentive/ Disincentive for all paving concrete, including water/cement ratio concrete, and high-early concrete provided by the Contractor's primary paving plant.

D.4.b Water/Cement (w/c) Ratio

Provide and place concrete with a water/cement ratio not to exceed 0.40. Make any adjustments immediately when the water/cement ratio exceeds 0.40.

The Department will not make incentive payments for water/cement ratio on high-early mixes.

Do not add water to the surface of the concrete to aid in finishing without the approval of the Engineer. Supply sufficient trucks to ensure a steady forward progress of the paver.

The Department will determine the water/cement ratio for concrete hauled in dump or agitator trucks (concrete hauled in truck mixers are not eligible for w/c ratio incentives) in accordance with the following:

D.4.b(1) Water Content Determination



For a concrete paving batch plant, use an electronic meter approved by the Engineer to record the water, including temper water, added to the mix that is capable of printing the amount of total water on each batch ticket.

For a ready-mix plant, record the total water added to the mix, including temper water, on the computerized Certificate of Compliance.

The Engineer will determine the water content for calculating the water/cement ratio using the average water calculated from 10 batch tickets or Certificates of Compliances surrounding the randomly selected batch ticket sample (four previous tickets, ticket representing the random sample, and the five following tickets).

D.4.b(2) Water Content Verification

The Engineer will use plastic concrete taken at the plant site to verify the water content in the mix as determined in accordance with 2301.2.D.4.b(1), "Water Content Determination." Sample the plastic concrete as directed by the Engineer.

The Engineer will verify the water content in the plastic concrete mixture using the test procedure specified in AASHTO T 318-02, "Standard Test Method for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying." The Engineer will begin the test within 45 min after the water has contacted the cement. Provide the microwave oven and the ancillary equipment as required by the Engineer to perform this test.

D.4.b(3) Cementitious Content Determination

The Engineer will determine the cementitious content for calculating the water/cement ratio using the average total cementitious calculated from 10 batch tickets or Certificates of Compliance surrounding the randomly selected batch ticket sample (four previous tickets, the ticket representing the random sample, and the five following tickets).

D.4.b(4) W/C Ratio Incentive/Disincentive

The Engineer will base the statistical analysis of acceptance for water/cement ratio in accordance with 2301.2.D.4.b(1), "Water Content Determination," and 2301.3.D.4.b(3), "Cementitious Content Determination," at a rate defined in the Schedule of Materials Control.

The Engineer will randomly choose acceptance samples. The Engineer will determine the sampling location by using a random number chart and multiplying the random number by the sampling rate as defined in the Schedule of Materials Control.

The Engineer will sample, test, and record the individual results.

If the quantities of concrete produced results in no Department moisture testing for any given day, include the untested quantity of concrete into the next day's production and include that quantity of concrete in the sampling rate. If the untested quantity is on the last day of production, add that quantity to the previous day's production.

Do not place concrete mix not meeting the 0.40 water/cement ratio requirement in the work. The Engineer may accept material not meeting the Contract requirements and the Department will pay for the work in accordance with Table 2301-8.

Table 2301-8	
W/C Ratio Incentive/Disincentive	
W/C Ratio Test Result	Payment incentive/disincentive per cu. yd [cu. m]
≤ 0.37	+\$3.00 [\$3.90]
0.38	+\$1.75 [\$2.25]
0.39	+\$0.50 [\$0.65]
0.40	\$0.00
0.41	-\$0.50 [\$0.65]
0.42	-\$1.75 [\$2.25]
0.43	-\$3.00 [\$3.90]
≥ 0.44	Determined by the Concrete Engineer

The Contractor may remove and replace concrete represented by water/cement ratios greater than 0.40. For concrete left in place with water/cement ratios greater than 0.40, if the level of payment is not defined in the table, the Engineer, in conjunction with the Concrete Engineer, will evaluate the material based on the adequacy of the material for the use intended. Remove and replace unsatisfactory concrete as determined by the Engineer at no additional cost to the Department.

D.4.c Well-Graded Aggregate Optional Incentive

The Engineer will use the Contractor's combined aggregate gradation test results, as verified by Department testing, to determine eligibility for the incentive.

The Contractor has two well-graded aggregate optional incentives available as follows:

- (1) Percent Retained Gradation Band in accordance with Table 2301-9.

Table 2301-9		
8-18 or 7-18 Percent Retained Gradation Band		
Sieve Size	8-18 % Retained	7-18 % Retained
2 in [50 mm]	0%	0%
1½ in [37.5 mm]	$\leq 9\%$	$\leq 9\%$
1 in [25 mm]	8-18%	7-18%
¾ in [19 mm]	8-18%	7-18%
½ in [12.5 mm]	8-18%	7-18%
⅜ in [9.5 mm]	8-18%	7-18%
No. 4 [4.75 mm]	8-18%	7-18%
No. 8 [2.36 mm]	8-18%	7-18%
No. 16 [1.18 mm]	8-18%	7-18%
No. 30 [600 µm]	8-18%	7-18%
No. 50 [300 µm]	$\leq 13\%$	$\leq 13\%$
No. 100 [150 µm]	$\leq 8\%$	$\leq 8\%$
No. 200 [75 µm]	$\leq 8\%$	$\leq 8\%$



- (2) Gradation Zone II-A of the Coarseness Factor Chart in accordance with Table 2301-10.

Table 2301-10	
Coarseness Factor Boundaries – Zone II-A	
Coarseness Factor (CF) *	Workability Factor (WF)
52	34–38
68	32–36
<p>* Coarseness Factor (CF) is defined as follows:</p> $CF = \frac{\text{Combined\% retained above } 3/8 \text{ in } [9.5 \text{ mm}] \text{ sieve}}{\text{Combined\% retained above No. 8 } [2.36 \text{ mm}] \text{ sieve}} \times 100$	
<p> Workability Factor (WF) is defined as follows:</p> $WF = \text{Combined \% passing No. 8 } [2.36 \text{ mm}] \text{ sieve}$	

The Engineer will use statistical analysis of the Contractor's combined aggregate gradation samples for well-graded aggregate on a lot basis representing one day's paving. The lot will represent the cumulative average of the subplot values on each sieve for the gradation band or the cumulative average of the subplot values of the coarseness factor and workability factor for the coarseness factor chart.

An optional incentive is available to the Contractor provided a concrete mixture is designed and produced with a well-graded aggregate gradation that meets one of the following in accordance with Table 2301-11. The Contractor may achieve only one of the optional incentives for any single lot.

Table 2301-11	
Well-Graded Aggregate Optional Incentive	
Gradation Options	Payment incentive/disincentive per cu. yard [cu. m]
8-18 Retained	\$2.00 per cu. yd [\$2.60 per cu. m]
7-18 Retained	\$0.50 per cu. yd [\$0.65 per cu. m]
Gradation Zone II-A	\$2.00 per cu. yd [\$2.60 per cu. m]

E	Reinforcement Bars.....	3301
F	Dowel Bars	3302
G	Concrete Joint Sealers	
G.1	Preformed Type.....	3721
G.2	Hot-poured, Elastic Type.....	3725
G.3	Silicone Type.....	3722
H	Preformed Joint Filler.....	3702

I	Curing Materials	
I.1	Burlap Curing Blankets.....	3751
I.2	Poly-Alpha Methylstyrene (AMS) Membrane Curing Compound	3754
I.3	Linseed Oil Membrane Curing Compound	3755
I.4	Plastic Curing Blankets.....	3756
J	Form Coating Material.....	3902
2301.3	CONSTRUCTION REQUIREMENTS	

Use "slipform" as the standard construction method for concrete paving, unless otherwise specified in the Contract or allowed by the Engineer.

A.1 High-Early Strength Sections

For early use of the pavement as required by the Engineer, construct a section of pavement of high-early strength concrete in accordance with 2301.2.D, "Concrete Mix Design Requirements," at important road crossings, intersections, driveway entrances, or other locations as shown on the plans or directed by the Engineer. Take precautions to satisfactorily finish, cure, and protect high-early strength concrete pavements.

A.2 Operation and Supervision

Notify the Engineer at least 24 h before placing concrete to allow for inspection. Do not place concrete until the Engineer approves preparations for concrete placement. If the Contractor fails to notify the Engineer at least 24 h before concrete placement, the Engineer may not allow concrete placement in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

Provide paving operations supervision in accordance with 1506, "Supervision by Contractor." Provide an organizational chart listing names and phone numbers of individuals and alternates responsible for mix design, quality control administration, and inspection to the Engineer. Post the organizational chart in the Contractor's on-site facility.

Provide a manufacturer's manual explaining the operation and adjustments of the major pieces of power operated equipment used.

A.3 Plant Certification

Provide notice 16 hrs in advance of concrete paving production and in conjunction with the Engineer, perform a thorough on-site inspection of the concrete plant and complete MnDOT Form 2164, "Concrete Paving Plant Contact Report." Sign the report to certify compliance with the paving requirements and to certify review of the continual maintenance of the plant.



Calibrate and correlate the testing equipment in accordance with 2461.3.D, "Batching Requirements."

A.3.a Combination Plant Lab – Office Requirements

The Concrete Paving Contractor QC technicians and the Department QA technicians will equally share a combination plant lab – office during concrete paving.

For concrete paving projects in accordance with 2301.2.D.2, "Concrete Pavement $\geq 3,500$ cu. yd [2,900 cu. m]," provide a separate combination plant lab – office in accordance with 1604, "Plant Inspection – Commercial Facility," except as modified by the following characteristics and requirements:

- (1) Located at the plant site within 100 yd [91 m] from the batch plant or other location, as approved by the Engineer,
- (2) Plant lab and plant office areas separated and isolated by a wall,
- (3) Total plant lab-office floor area, based on exterior dimensions, of at least 224 sq. ft [21 sq. m],
- (4) Plant lab floor area, based on exterior dimensions, of at least 144 sq. ft [13.5 sq. m],
- (5) Plant office floor area, based on exterior dimensions, of at least 80 sq. ft [7.5 sq. m],
- (6) Heating and cooling system capable of maintaining a uniform temperature between 72° and 85° F [22° and 29° C],
- (7) Drinking water container or cooler with adequate supply of potable water,
- (8) Detached portable toilet conveniently located,
- (9) Electrical power supply that provides adequate amperage for all electrical needs,
- (10) Water supply (storage tank with a capacity of 50 gal or more, or pressurized water supply) connected to the sink faucet,
- (11) Provide a sample storage area to prevent contamination of the samples,
- (12) Plant lab furnished in accordance with the following:
 - (12.1) One sturdily-built workbench or countertop at least 30 in \times 144 in [0.75 m \times 3.65 m],
 - (12.2) One service sink located near one end of the workbench with a water supply, faucet and an outside drain,
 - (12.3) Shelf space above workbench or countertop or at other convenient locations, totaling at least 8 linear ft [2.5 m] \times 8 in [0.2 m],
 - (12.4) Electronic scales of sufficient size to weigh the samples for all required materials testing, and
 - (12.5) A four (4) burner 30" standard electric stove top or stove and at least two (2) additional electric burners to perform required aggregate testing per the Schedule of Materials Control.
 - (12.6) Microwave oven with turntable or wave deflection fan (900 Watt), heat resistant glass pan (approx. 9"x9"x2"), plain weave fiberglass cloth (10 oz/yd² and 14 mills thick), metal scrapper and grinding pestle,
 - (12.7) Metal bowls of sufficient size to perform all required material testing,
- (13) Plant office furnished in accordance with 2031.3.B.1, "Field Office Furnishings," except as modified by the following:
 - (13.1) Two desks, one for the Department and one for the Contractor, with total exterior dimensions of at least 30 in \times 60 in [$\frac{3}{4}$ m \times 1.50 m],
 - (13.2) At least four (4) desk chairs,
 - (13.3) A telephone capable of providing email, and

(13.4) A printer with scanning and copying capabilities.

For concrete paving projects supplied by a Certified Ready-Mix Plant, the separate Combination Plant - Lab Office requirements of 2301.2.A.3.a do not apply with the exception of the following:

- (1) Electrical power supply that provides adequate amperage for all electrical needs,
- (2) Water supply (storage tank with a capacity of 50 gal or more, or pressurized water supply) connected to the sink faucet,
- (3) Electronic scales of sufficient size to weigh the samples for all required materials testing, and
- (4) At least six (6) electric burners to perform required aggregate testing per the Schedule of Materials Control.
- (5) Metal bowls of sufficient size to perform all required material testing,
- (6) If w/c incentives apply, provide a microwave oven with turntable or wave deflection fan (900 Watt), heat resistant glass pan (approx. 9"x9"x2"), plain weave fiberglass cloth (10 oz/yd² and 14 mills thick), metal scrapper and grinding pestle,

Do not begin concrete paving operations until the Engineer approves the combination plant lab-office.

A.4 Sampling and Testing

Provide a MnDOT Certified Concrete Plant Level 2 Technician to oversee testing and plant operations and to remain on-site during concrete production or have cellular phone availability.

Provide technicians with certifications at least meeting MnDOT Concrete Plant Level 1 to perform all of the duties in accordance with the Concrete Manual. The Engineer will provide technicians with certifications at least meeting MnDOT Concrete Plant Level 1 to perform all of the duties in accordance with the Concrete Manual.

Perform testing in the accordance with the Concrete Manual and determine testing rates in accordance with the requirements of the Schedule of Materials Control. The Engineer performs testing in accordance with the Concrete Manual and determines testing rates meeting the requirements of the Schedule of Materials Control.

Take samples randomly using ASTM D 3665, Section 5.

A.5 Contractor Charting

Maintain and keep control charts current. Provide and display easily readable sized charts (letter-sized paper) on the testing facility wall or store in a 3-ring binder. Plot the following information on control charts using a method approved by the Engineer:

- (1) Composite gradation,
- (2) Air content (QC and QA),
- (3) Moisture content of aggregates, and
- (4) Water/cement ratio.

Also include the following information on the charts:



- (1) Date,
- (2) Time,
- (3) Lot and subplot,
- (4) Admixture dosage adjustments, and
- (5) Other data necessary to facilitate control of the process.

Provide all reports, records, and diaries developed during the progress of construction activities to the Engineer. Provide all batch tickets and test results to the Engineer on a daily basis. The Engineer may suspend plant operations if the Contractor fails to provide daily test results.

A.6 MIT-SCAN T2 Non-Destructive Testing Device

The Contractor shall furnish a MIT-SCAN T2 non-destructive testing device having the ability to measure the location of concrete reinforcement, dowel bars and concrete pavement thickness in a single device. Agency and Contractor personnel shall mutually use this non-destructive testing device several times a day during concrete pavement construction.

The Contractor shall perform the following in the hardened concrete:

- (1) For transverse joints the entire paved width
 - (1.1) On first day, Scan one joint out of every five joints to verify dowel bar alignment and process.
 - (1.2) If first day is acceptable, scan one joint out of every 500 feet as well as scan one joint out of every five joints on a 500 foot random segment each day for the remainder of the project.
 - (1.3) If a joint is found to have dowel bars out of acceptable alignment tolerances, scan joints on both sides until alignments meets acceptable tolerances.
- (2) For longitudinal L1T joints
 - (2.1) On first day, scan 75 feet out of every 1000 feet, as well as scan one 500 foot random segment, to verify tie bar alignment and process.
 - (2.2) If first day is acceptable, scan 75 feet out of every 5000 feet as well as scan one 500 foot random segment each day for the remainder of the project.
 - (2.3) If a panel is found to have 2 or more tie bars missing or out of acceptable alignment tolerances, scan joints on both ends until 5 consecutive panels meets acceptable alignment tolerances.

Contact the Concrete Engineer for recommendations if alignment tolerances are not met.

Agency observations do not relieve the Contractor of the requirement to properly place the concrete reinforcement and dowel bars as shown in the plans. In addition, the Department reserves the right to reject the pavement in accordance with 1503, "Conformity with Plans and Specifications" and 1512, "Unacceptable and Unauthorized Work."

The Engineer will not provide additional payment for furnishing the above equipment for the Department's use.

B Subgrade and Aggregate Base Preparations

Prepare the subgrade and aggregate base in accordance with 2112, "Subgrade Preparation," and 2211, "Aggregate Base," and the following:

Fine grade the aggregate base to the shape and grade shown on the plans, allowing construction of the pavement to the thickness and cross section shown on the plans. Use an approved fine grading machine mounted on crawler tracks.

Shape and maintain the shoulders to allow surface water to drain away from the pavement and off the shoulders.

C Setting Forms

Provide forms meeting the following requirements and characteristics:

- (1) Steel, straight edge sides,
- (2) Depth equal to the pavement thickness shown on the plans,
- (3) Smooth and free of localized indentations and deformities,
- (4) Top face with deviations no greater than $\frac{1}{8}$ in [3 mm] in any 10 ft [3 m] section,
- (5) Faces of straight forms with deviations no greater than $\frac{1}{4}$ in [13 mm] in any 10 ft [3 m] section,
- (6) Side forms containing no bends or damaged sides,
- (7) Forms containing no damaged joint locks or pin pockets, and
- (8) Form lengths at least 10 ft [3 m] long with horizontal joint and base width equal to the depth of the forms.

For pavements with radii no greater than 100 ft [30 m], use flexible or curved forms approved by the Engineer. Provide devices to securely set forms and withstand operation of the paving equipment without springing, settlement, or lateral displacement. Provide forms with joint locks to tightly join the ends of abutting form sections. Connect individual form sections using methods that create a continuous form.

Set the forms to the alignment and grade shown on the plans for a distance equal to at least 3 h ahead of concrete placement.

Compact the foundation before placing the forms in accordance with 2301.3.B, "Subgrade and Aggregate Base Preparations." Ensure the forms have a firm and uniform bearing over the entire base area, are tightly joined and securely staked, and are clean and free of accumulations of hardened concrete. Coat the contact faces of the forms with an approved form coating material in accordance with 3902, "Form Coating Material," before placing the concrete.

During a rain event, remove and reset the forms as necessary to allow drainage.

D Concrete Equipment and Paving Operations

Provide self-propelled spreading and finishing machines capable of consolidating and finishing the concrete, and producing a dense and homogeneous finished surface meeting the requirements specified in 2301, "Concrete Pavement."



D.1 Slipform Construction

Place concrete using a slipform paver or combination of pavers designed to spread, consolidate, screed, and float-finish the freshly placed concrete with minimum hand finishing. Provide a slipform paver with a non-oscillating extrusion plate with an adjustable angle of entry.

Place the concrete pavement before placing curb and gutter.

If the sequence of operations includes placing the curb and gutter before the concrete pavement, submit a jointing plan to the Engineer for approval before placing the curb and gutter.

Consolidate the full width and depth of concrete pavement placed by a single pass of a series of internal vibrators. Operate full-width vibrators from 3,600 VPM to 7,000 VPM [60 Hz to 117 Hz] in concrete, and from 4,150 VPM to 8,000 VPM [70 Hz to 133 Hz] when checked in air. Deliver the vibrator impulses directly to the concrete and operate at an intensity to consolidate the concrete uniformly throughout the entire depth and width of the concrete. The Contractor may increase the vibrator frequency as approved by the Engineer. Perform additional testing as directed by the Engineer at no additional cost to the Department. If the vibrator fails, suspend operations and remove unconsolidated concrete.

Regulate the rate of progress of the vibratory equipment and the duration of the application to fully, but not excessively, vibrate the concrete. If the forward progress of the paver stops, suspend the operation of vibrators.

Attach vibrators to spreading or finishing equipment. Do not allow vibrators to come in contact with preset dowel basket assemblies, the grade, pavement reinforcement, or side forms. Do not allow the operation of vibrators to cause separation or segregation of the mix ingredients, including the downward displacement of large aggregate or the accumulation of laitance on the concrete surface. The Contractor may reduce the vibration frequency within the specified range if reducing the forward progress of the paver to avoid segregation of the concrete mix. Connect the power to all vibrators so that they cease when the machine motion is stopped. Stop paving operations if a vibrator fails to operate within the range specified above.

Provide an electronic monitoring device meeting the following characteristics and requirements to display the operating frequency of each individual internal vibrator for concrete pavement placed by the slipform method:

- (1) Contains a readout display near the operator's controls; visible to the paver operator and to the Engineer,
- (2) Operates continuously as the paving machine operates,
- (3) Displays all the vibrator frequencies with manual and automatic sequencing for each of the individual vibrators, and
- (4) Records the following at least every 25 ft [7.62 m] of paving or at least every 5 min of time:
 - (4.1) Clock time,
 - (4.2) Station location,
 - (4.3) Paver track speed, and
 - (4.4) Operating frequency of individual vibrators.

Provide an electronic copy containing the record of data after the completion of the concrete paving operation. Provide vibration data daily as directed by the Engineer.

Operate the slipform paver with a continuous forward movement, and coordinate all operations of mixing, delivering, and spreading concrete to provide uniform progress with minimal stopping and starting of the paver.

Equip the paver with automatic grade control capable of maintaining both the elevation and longitudinal line shown on the plans at both sides of the paver by controlling the elevation of one side and controlling the crown, or by controlling the elevation of each side independently. Use an erected string line to achieve the grade reference.

Tightly stretch a wire or string line set parallel to the established grade for the pavement surface to achieve the grade reference. Set the control reference and support the line at intervals to maintain the established grade and alignment.

When constructing concrete overlays, set and use stringlines for grade control on both sides of the roadway during paving operations.

D.2 Fixed Form Construction

Place concrete using one or more machines to spread, screed, and consolidate between previously-set side forms. Accomplish vibration of these areas using hand-held or machine-mounted internal vibrators.

If not using an electronic monitoring device, use a tachometer or similar device to demonstrate to the Engineer that the paving equipment vibration meets the requirements in this section.

Use hand-held vibrators to consolidate concrete adjacent to side forms and fixed structures. Operate the hand-held vibrators at a speed of at least 3,600 VPM [60 Hz]. Do not allow the vibrator head to contact the joints, load transfer devices, reinforcement, grade, or side forms. If the vibrator fails, suspend operations and remove unconsolidated concrete.

Continue vibration to achieve adequate consolidation, without segregation, for the full depth and width of the area placed.

Provide an adequate number and capacity of machines to perform the work at a rate equal to the concrete delivery rate.

Strike-off concrete with a clary screed, unless otherwise approved by the Engineer. Finish small or irregular areas that are inaccessible to finishing equipment using other methods as approved by the Engineer.

Discontinue any operation that causes displacement of the side forms from the line or grade or causes undue delay, as determined by the Engineer, due to mechanical difficulties.

E Batching and Mixing

Batch and mix the concrete in accordance with 2461, "Structural Concrete," and the following:



E.1 Batching Requirements

Perform the initial spot check of the measuring equipment in accordance with the Concrete Manual for accuracy and sensitivity before starting production operations. Provide a copy of the inspection certificate to the Engineer.

Provide to the Engineer a computerized batch ticket that includes the following:

- (1) Date,
- (2) State project number (SP) or (SAP),
- (3) Time concrete was batched,
- (4) Quantity of concrete in this load,
- (5) Running total of each type of concrete, each day for each project,
- (6) Mix number,
- (7) Labels identifying each material that correlates with the Contractor mix design, including cementitious and admixture abbreviations or MnDOT 5 digit pit numbers),
- (8) Target weight of materials,
- (9) Actual batched weights of materials,
- (10) Temper water, and
- (11) Total water weight.

If satisfactory finishing and curing of the pavement does not occur, as determined by the Engineer, suspend batching and mixing operations.

E.2 Concrete Ingredient Summaries

If delivering bulk cementitious materials directly to the concrete batching plant in railroad cars or sealed transport trucks, submit copies of the bill of lading to the Engineer on the same day received from the transporting company.

Advise the Engineer of the method and schedule of cementitious material unloading. Do not unload cementitious materials until the Engineer approves the operation.

Each day of concrete pavement production, provide the Engineer with a production summary in an electronic format that includes the following:

- (1) Daily total concrete produced in cubic yards for each concrete mixture type.
- (2) Daily total ingredient quantities (aggregate, cementitious and water) including the percent overrun/underrun.

The Contractor shall provide final project total quantities for (1) and (2) to the Engineer at the end of the Project.

The Engineer will verify the following:

- (1) Individual daily cement quantity do not show an underrun in cement usage greater than 1.0 percent of the quantity specified,
- (2) The final cement quantity summary does not show an overall underrun greater than 1.0 percent, and
- (3) If either one or both of these limitations are exceeded, the Engineer will not pay for the concrete represented at the Contract unit price.

The Engineer may reject defective concrete in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work," or the Department may pay for the defective concrete at an adjusted unit price at the same ratio to the Contract unit price as the quantity of cement used to the quantity of cement required less the allowable underrun. If the cement exceeds the limitations for individual cutoff and final cutoff, the Department may apply the price adjustment to the cutoff value that produces the greatest monetary deduction.

F Placing Concrete

Dump or discharge concrete without causing grade displacement or damage to the existing asphalt or bond breaker layer. Repair damage to the grade, existing asphalt or bond breaker layer as approved by the Engineer at no cost to the Department. Provide protection for turning concrete trucks.

Maintain the grade in a moist condition until placement of concrete.

Construct mainline pavement in a single layer of concrete. Place the concrete pavement in one complete pass of the paving machine to minimize the need for hand finishing.

Coordinate paving operations for mixing, delivering, spreading, and extruding the concrete to provide uniform progress of the paver. Use sufficient trucks to ensure a steady forward progress of the paver. If the forward movement of the paver stops for a period long enough to create a cold joint or honeycombing, construct a header joint in accordance with 2301.3.H.3, "Constructing Headers."

Do not add water to the surface of the concrete to aid in finishing without the approval of the Engineer.

When placing concrete on asphalt or asphalt bond breakers, comply with the following:

- (1) Do not place concrete on an asphalt surface with an asphalt surface temperature greater than 120 °F [50 °C].
- (2) Maintain the asphalt surface in a moist condition as necessary and at a surface temperature not greater than 120 °F [50 °C] before placing the concrete. The Engineer will allow the Contractor to apply water, whitewash of hydrated lime and water, or both to cool the asphalt surface, or other methods allowed by the Engineer.
- (3) Before placing concrete on a milled asphalt surface, clean the milled surface by sweeping and patch as shown on the plans in accordance with 2231, "Bituminous Surface Reconditioning," or as directed by the Engineer.

When placing concrete adjacent to in-place concrete pavement, protect the following:

- (1) All ends of transverse joints $\frac{3}{16}$ in [5 mm] or wider to the satisfaction of the Engineer. The Engineer will allow sawing through the existing joint when sawing the newly placed concrete, and



- (2) The in-place pavement to prevent damage.

Do not allow the edges of the pavement, including longitudinal joints, to deviate from the line shown on the plans by greater than $\frac{1}{2}$ in [13 mm] at any point.

Set manhole and catch basin frames or rings to the elevation shown on the plans during the paving operations.

F.1 Consistency

For slipform concrete pavement placement, place the concrete with a slump value that optimizes placement, except ensure the concrete does not slough or slump and is adequately consolidated and meets all other requirements of 2301, "Concrete Pavement." Maintain the concrete at a uniform consistency. The Engineer will not allow an edge slump greater than $\frac{1}{8}$ in [3 mm] or irregular edge alignment.

For fixed form placement, place the concrete with a slump no greater than the maximum allowable slump in accordance with 2461.3.G.6, "Consistency."

F.2 Air Content

Maintain the air content of Type 3 paving concrete at the specified target of 7.0 percent ± 1.5 percent of the measured volume of the plastic concrete before consolidation in accordance 1503, "Conformity with Contract Documents."

Make any adjustments immediately to maintain the desired air content.

Measure the air content after placement on the grade but before consolidation.

If using the slipform paving method, establish an air-loss correction factor (ACF) to determine the air content after consolidation once per half day of paving. Apply the ACF to tests taken before consolidation to estimate the air content after consolidation. Place concrete with an air content of at least 5.0 percent after consolidation.

Take the following actions for the following air content test results with the ACF applied or a test taken after consolidation:

- (1) A single test (QC or QA) from 5.0 percent to 5.5 percent, adjust the mix design to obtain an air content greater than 5.5 percent without stopping production.
- (2) Two consecutive tests (QC or QA) from 5.0 percent to 5.5 percent, make immediate adjustments to obtain an air content greater than 5.5 percent or stop production. Test every truck until the air content test results meet the requirements. Test at least three additional trucks after obtaining the correct air content.
- (3) Any test (QC or QA) less than 5.0 percent, make immediate adjustments to obtain an air content greater than 5.5 percent or stop production. Test every truck until the air content meets the requirements. Test at least three additional trucks to ensure the concrete remains within compliance. Perform additional testing on the hardened concrete as required by the Engineer in conjunction with the Concrete Engineer.

F.2.a Non-Conforming Material

Only place Type 3 concrete meeting the air content requirements in the work. If the Contractor places Type 3 concrete not meeting the air content requirements into the work, the Engineer will not accept nonconforming concrete at the Contract unit price. For concrete not meeting the required air content, the Engineer will make determinations regarding the disposition, payment, or removal. The Department will adjust the Contract unit price for the Contract pay item of the concrete in accordance with Table 2301-12. When there is not a separate structural concrete Contract unit price for a Contract item, the Department will reduce payment based on a concrete price of \$60.00 per cu. yd [\$78.00 per cu. m] or the Contractor-provided invoice amount for the concrete in question, whichever is less.

Table 2301-12 Paving Concrete	
Air Content Before Consolidation, %	Adjusted Contract Unit Price
>10.5	The Department will pay 75 percent of the Contract unit price for the concrete represented and placed as approved by the Engineer.
>8.5 – ≤10.5	The Department will pay 95 percent of the Contract unit price for the concrete represented and placed as approved by the Engineer
5.5 – 8.5	The Department will pay 100 percent of the Contract unit price for the concrete represented and placed as approved by the Engineer
>4.5 – <5.5	The Department will pay 75 percent of the Contract unit price for the concrete represented and placed as approved by the Engineer
>4.0 – ≤4.5	The Department will pay 25 percent of the Contract unit price for the concrete represented and placed as approved by the Engineer. If the Engineer, in conjunction with the Concrete Engineer, determines the surface is exposed to freeze-thaw cycling, coat the concrete with an epoxy penetrant sealer from the Approved/Qualified Products List.
≤ 4.0	Remove and replace concrete in accordance with 1503, "Conformity with Contract Documents" and 1512, "Unacceptable and Unauthorized Work" as directed by the Engineer. If the Engineer, in conjunction with the Concrete Engineer, determines the concrete can remain place, the Engineer will not pay for the concrete and if the Engineer determines the surface is exposed to salt-brine freeze-thaw cycling, coat with an epoxy penetrant sealer from the Approved/Qualified Products List.

G Placing Reinforcement

Provide and place reinforcement meeting the following requirements and characteristics:

- (1) Provide epoxy coated reinforcement in accordance with 2472, "Metal Reinforcement."
- (2) Provide and place reinforcement bars including keyway bars, tie bars, taper steel, and stopper bars.
- (3) Place keyways as shown on the plans.
- (4) Provide and place supplemental pavement reinforcement as shown on the plans.



- (5) Provide and place reinforcement bars on chairs, in stakes, utilizing tie bar basket assemblies or by appropriate equipment for depressing the bars to the specified location.
- (6) For slipform paving, stake the tie bar steel to the roadbed, or use a mechanical device attached to the spreader or paver to place tie bar steel required for L1T joints as shown on the plans. Space and depress the tie bar steel to the depth and location shown on the plans. Do not place tie bars over a dowel bar assembly.

H Joint Construction

Unless otherwise shown on the plans, construct all joints perpendicular to the grade. Place dowel bars parallel to the grade and parallel to the centerline of the pavement.

H.1 Dowel Bar Placement

Provide dowel bar assemblies manufactured in single units for the lane widths shown on the plans, unless otherwise approved by the Engineer. Do not use more than two assembled sections in any one joint for ramps, loops, and tapered sections.

Secure the dowel bar assemblies to prevent movement during concrete placement in accordance with Standard Plate 1103 and the following:

- (1) If placing dowel bar assemblies on asphalt or asphalt bond breaker layers, secure the assemblies with at least seven anchorage points. Place four of the anchorage points on the assembly side facing the front of the paver. Fasten the assemblies in accordance with the following:
 - (1.1) Place pins or fasteners of sufficient length and shank diameter of at least 0.177 in [0.45 cm] to penetrate through the asphalt bond breaker layer and into the concrete at least 1 in [25 mm] or at least 2 in [50 mm] into the in-place asphalt layer.
 - (1.2) Before paving, demonstrate the fastening method to the Engineer for approval.

Within 1 h before covering with concrete, coat the dowel bars with a thin uniform coating of a form coating material in accordance with 3902, "Form Coating Material."

Before placing the concrete, mark the location on both sides of each transverse joint as approved by the Engineer. Transfer the markings to the fresh concrete immediately after completing the final finishing operations.

The Contractor may use a mechanical dowel bar inserter to place dowel bars in the pavement as approved by the Engineer, in conjunction with the Concrete Engineer. Immediately before inserting the dowels, coat the dowels with a thin uniform coating of a form coating material in accordance with 3902, "Form Coating Material." If using a dowel bar inserter, initially and on each production day, demonstrate to the Engineer that the inserted dowel bars in the completed concrete pavement are parallel to the surface and centerline slab and are located at mid-depth of the slab thickness.

H.1.a Quality Control Plan for Dowel Basket Assemblies

Provide a Quality Control Plan in writing to the Engineer for acceptance that provides a method for keeping the dowel basket assemblies anchored to the existing asphalt or bond breaker layer and into the underlying concrete. The Quality Control Plan shall include the following at a minimum:

- (1) Proposed type and number of fasteners
- (2) Dowel basket assembly anchoring plan (ie. Anchored all basket assemblies prior to concrete placement, one lane at a time, anchor all basket assemblies during the concrete placement operation, etc.)
- (3) Procedure if assemblies do not hold with the proposed method
- (4) Sampling rate for locating basket assemblies with the MIT-SCAN T2

H.2 Joint Establishment

Space contraction joints at the intervals shown on the plans, except shorten the spacing at the following to provide panel lengths at least 5 ft [1.5 m]:

- (1) Adjacent to header joints,
- (2) Reinforced panels,
- (3) Railroad grade crossings, and
- (4) Free ends of pavement.

Provide either wet-cut saws referred to as “conventional concrete saws” or lighter weight dry-cut saws referred to as “early-entry concrete saws” capable of establishing joints sooner than the conventional saws.

Provide initial joint sawing as shown on the plans. Perform the initial sawing as soon as the concrete will support the joint sawing operation without raveling and before random cracking occurs.

Immediately after completing the joint sawing, use water under nozzle pressure to remove the sawing residue from each joint and the pavement surface.

If widening is necessary, do not widen the joints to full width until the concrete is at least 24 h old, or longer if the sawing causes raveling of the concrete.

Stake preformed joint filler material for expansion joints in place to maintain the position shown on the plans during concrete placement.

Extend transverse joints constructed in the pavement through the integrant curb.

H.3 Constructing Headers

Construct construction headers, temporary headers, and permanent headers as shown on the plans.

The Engineer will not allow incorporating any concrete accumulated in the grout box of the paver into the pavement. Construct all headers such that the concrete contained in the grout box is removed from the project. Use any approved construction header method as shown in the Standard Details.

Use internal vibration to consolidate the concrete along header joints before final finishing.

I Surface Finishing

Use a $\frac{3}{8}$ in [10 mm] radius edging tool to finish edges of the pavement.



After consolidating, screeding, and floating the concrete, give the pavement surface a final finish texture in accordance with 2301.3.I.1, "Pavement Texture."

I.1 Pavement Texture

Pull a carpet drag or broom drag longitudinally along the pavement before the concrete attains its initial set to obtain the final finish. Mount the drag on a bridge. Provide a drag with the following dimensions:

- (1) As wide as the concrete placed, and
- (2) Longitudinal length with sufficient surface contact to produce a texture approved by the Engineer.

When using a carpet drag method, provide an artificial grass type carpeting for the carpet drag meeting the following characteristics and requirements:

- (1) Molded polyethylene pile face,
- (2) Blade length from $\frac{5}{8}$ in to 1 in [15 mm to 25 mm], and
- (3) Total weight of at least 70 oz per sq. yd [2.35 kg per sq. m].

The Contractor may use manual methods to achieve similar results on ramps and other locations as approved by the Engineer. The Contractor may use other texturing equipment to obtain an equivalent texture as approved by the Engineer.

Test the adequacy of the pavement skid resistance meeting the requirements of ASTM E 965-87, "Test Method for Measuring Surface Macrotexture Depth Using a Sand Volumetric Technique." Provide a texture depth of at least $\frac{1}{25}$ in [1.00 mm].

The Department defines a lot as pavement of a single lane. Establish a separate lot for each lane on the project.

The Department defines a subplot as the rate at which an individual measurement is taken over a given length. The Department considers a subplot as one lane wide, measured in accordance with the following:

- (1) From the pavement edge to the adjacent longitudinal joint,
- (2) From one longitudinal joint to the next, or
- (3) In the absence of a longitudinal joint, between pavement edges.
- (4) Each ramp and loop 18 ft [5.5 m] wide or less is considered a single lane.

The Engineer will break lots into sublots representing 1,000 linear ft [300 m] of pavement. Test the pavement surface at a point located transversely in the outside wheel path as determined by the Engineer. Test adjoining driving lanes at the same location. The Engineer will provide the Contractor with the locations using a random number multiplied by length of the subplot within 24 hours of pavement placement. If the project or individual lane results in less than three sublots, the Engineer will divide the project or individual lane lot into three sublots of equal length.

Complete surface texture testing no later than 48 h after pavement placement unless otherwise approved by the Engineer. Refer to Table 2301-13 for the acceptance criteria of texture depths below the

specification limits. If the Engineer determines by visual inspection, that areas not represented by random testing appear to not meet the minimum requirements of Table 2301-13, the Engineer reserves the right to require additional testing in those specific areas to determine compliance.

Table 2301-13 Pavement Texture Depth	
Texture Depth Test Results for Individual Tests	Acceptance Criteria
$< \frac{1}{25}$ in to $\geq \frac{1}{32}$ in [< 1.00 mm to ≥ 0.80 mm]	The Engineer will accept the work if the Contractor amends the operation to achieve the required depth of at least $\frac{1}{25}$ in [1.00 mm] as approved by the Engineer. If the Contractor fails to correct the operation, the Engineer will suspend the paving operation until corrections produce the required results.
$< \frac{1}{32}$ in [< 0.80 mm]	Perform concrete grinding of the pavement represented by this test to attain the necessary texture of $\frac{1}{25}$ in [1.00 mm] as required by the Engineer.

Run additional tests at 100 ft [30 m] intervals before and after the failing test location to determine the limits of any individual failing test.

J Concrete Curing and Protection

After completing final finishing operations, cure all exposed concrete surfaces. Use one of the following curing methods:

- (1) Place the membrane curing compound conforming to 3754, "Poly-Alpha Methylstyrene (AMS) Membrane Curing Compound," or 3755, "Linseed Oil Membrane Curing Compound," within 30 minutes of concrete placement or once the bleed water has dissipated, unless the Engineer directs otherwise in accordance with 2301.3.J.1.a, "Membrane Curing Method." Place the membrane curing compound on the edges within 30 minutes after permanent removal of the forms or curing blankets, unless the Contract requires otherwise.
- (2) Place plastic curing blankets or completely saturated burlap curing blankets in accordance with 2301.3.J.1.b, "Curing Blanket Method," as soon as practical without marring the surface.

Whenever weather conditions are such as to cause unusual or adverse placing and finishing conditions or equipment failures occur, expedite the application of a curing method or temporarily suspend the mixing and placing operations, as the conditions require.

If necessary to remove the coverings to saw joints or perform other required work, and if the Engineer approves, remove the covering for the minimum time required to complete that work.

Failure to comply with the above provisions will result in the Engineer, in conjunction with the Concrete Engineer, applying a monetary deduction in accordance with 1503, "Conformity with Contract Documents." When there is not a separate Contract unit price for Structural Concrete, the Department



will apply a monetary deduction of \$30.00 per cu. yd [\$39.00 per cu. m] or 50 percent of the Contractor-provided invoice amount for the concrete in question, whichever is less.

J.1 Curing Methods

J.1.a Membrane Curing Method

Before application, agitate the curing compound as received in the shipping container to obtain a homogenous mixture. Protect membrane curing compounds from freezing before application. Handle and apply the membrane curing compound in accordance with the manufacturer's recommendations.

Apply the curing compound in accordance with the following:

- (1) At a rate of 1 gal per 150 sq. ft (1 L per 4 m²) of surface curing area.
- (2) Apply curing compound homogeneously to provide a uniform, solid, white opaque coverage on all exposed concrete surfaces (equal to a white sheet of typing paper). If using a Department approved curing compound with a non white base color, apply the compound to provide a uniform, solid, opaque consistency meeting the intent of the requirement in this section.
- (3) If the curing compound is damaged during the curing period, immediately repair the damaged area by re-spraying.
- (4) If the Engineer determines that the initial or corrective spraying result in unsatisfactory curing, the Engineer may require the Contractor to use the blanket curing method, at no additional cost to the Department.

Use the fully-automatic, self-propelled mechanical power sprayer approved by the Engineer to apply the curing compound in accordance with the following:

- (1) Operate the equipment to direct the curing compound to the surface from two different lateral directions,
- (2) Do not allow the sprayer to ride on the pavement surface,
- (3) Ensure the sprayer covers the entire lane width and atomizes the curing compound, and
- (4) If puddling, dripping, or non-uniform application occurs, suspend the operation to perform corrections as approved by the Engineer.

Use a fully automatic, self propelled mechanical power sprayer equipped with the following to apply curing compound as approved by the Engineer:

- (1) A re-circulating bypass system that provides for continuous agitation of the reservoir material,
- (2) Separate filters for the hose and nozzle,
- (3) Check valve nozzles,
- (4) Multiple or adjustable nozzle system that provides for variable spray patterns,
- (5) A shield to control loss of material by wind action, and
- (6) A spray-bar drive system that operates independently of the wheels or track drive system.

For applying the curing compound on pavements that are 10 ft [3 m] wide or less and irregular shaped surfaces, the Engineer will allow an airless spraying machine that complies with the following:

- (1) A re-circulating bypass system that provides for continuous agitation of the reservoir material,
- (2) Separate filters for the hose and nozzle, and
- (3) Multiple or adjustable nozzle system that provides for variable spray patterns.

J.1.b Curing Blanket Method

After completion of the finishing operations and without marring the concrete, cover the concrete with curing blankets. Install in a manner that envelops the exposed concrete and prevents loss of water vapor. After the concrete has cured, apply membrane curing compound to the concrete surfaces that will remain exposed in the completed work.

J.2 Protection Against Rain

Protect the concrete from damage due to rain. Have available, near the site of the work, materials for protection of the edges and surface of the concrete. Should any damage result, the Engineer will suspend operations until corrective action is taken and may subject the rain-damaged concrete to 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

J.3 Protection Against Cold Weather

If the national weather service forecast for the construction area predicts air temperatures of 36 °F [1 °C] or less within the next 24 h and the Contractor wishes to place concrete, the Contractor shall submit a cold weather protection plan.

Protect the concrete from damage, including freezing due to cold weather. Should any damage result, the Engineer will suspend operations until corrective action is taken and may subject the damaged concrete to 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

J.3.a Cold Weather Protection Plan

Submit a proposed time schedule and plans for cold weather protection of concrete in writing to the Engineer for acceptance that provides provisions for adequately protecting the concrete during placement and curing. Do not place concrete until the Engineer accepts the cold weather protection plans.

J.4 Vibratory and Backfilling Protection

Protect newly placed concrete from damage by adjacent vibratory or backfilling operations for a minimum of 24 h. Resume vibratory and backfilling operations after the concrete has reached a minimum compressive strength of 2,000 psi [13.7 MPa] or a flexural strength of 250 psi [1.7 MPa]. Cast concrete control specimens in accordance with 2461.3.G.5, "Test Methods and Specimens." The Engineer will test the control specimens. If the Engineer discovers evidence of damaged concrete, the Engineer will suspend work until the Contractor corrects the work. The Engineer may reject damaged concrete in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."



The Contractor may use hand-operated concrete consolidation equipment, walk-behind vibratory-plate compactors, rollers in “static” mode, and fine grading machines 24 h after placing the concrete, and other equipment as approved by the Engineer, in conjunction with the Concrete Engineer.

K Removal of Forms

Do not remove side forms of pavement and back forms on integrant curb earlier than 12 h after placing the concrete, unless otherwise approved by the Engineer. Remove forms without exerting shock or strain, including temperature variations, on the pavement or curb. Cure concrete in accordance with 2301.3.J.1.a, “Membrane Curing Method.”

L Joint Sealing

Provide a joint sealant in accordance with 3725, “Hot-Poured, Extra-Low Modulus, Elastic-Type Joint and Crack Sealer,” unless the type of sealant for contraction joints is otherwise specified in the Contract.

If the concrete mixture contains Class B coarse aggregate as defined in 3137, “Coarse Aggregate for Portland Cement Concrete,” do not seal joints with silicone.

Perform joint sealing as shown on the plans and in accordance with the following:

- (1) Seal joints after the Engineer inspects and approves the joints;
- (2) Perform joint sealing on surface dry concrete after cleaning the joints of debris, dirt, dust, and other foreign matter, including accumulations of concrete;
- (3) Lightly sandblast the joint walls before final compressed air cleaning;
- (4) Immediately before sealing the joints, clean the joints with a jet of compressed air under pressure of at least 85 psi [580 kPa];
- (5) Seal transverse integrant curb joints with the same joint sealer used to seal the pavement joints;
- (6) Seal joints in accordance with the tolerances shown on the plans;
- (7) Provide backer rod material compatible with the sealer as shown on the plans; and
- (8) Remove and replace sealer at joints filled above the permissible level shown on the plans at no additional cost to the Department.

Handle and place joint sealer material as recommended by the manufacturer and in accordance with the following requirements:

L.1 Hot-Poured Sealers

Heat hot-poured sealers in a double-boiler type kettle or melter. Fill the space between inner and outer shells with oil or other material as allowed by the manufacturer. Provide heating equipment with automatic temperature control, mechanical agitation, and recirculating pump. Use heating equipment as recommended by the manufacturer of the sealer material. Do not melt quantities of sealer material greater than the quantity used within the same day. After heating the sealer material to the application temperature, maintain the material temperature until placement. Place the sealer material within 4 h after the initial heating to the application temperature.

Apply sealant to the pavement at ambient pavement temperatures greater than 39 °F [4 °C].

L.2 Silicone Sealers

Install silicone sealers as recommended by the manufacturer.

L.3 Preformed Sealers

Provide preformed seals in one continuous length for each joint, except the Contractor may use butt splices in transverse joints at longitudinal joints.

Do not stretch the preformed sealer material in the installation process by greater than 5 percent of the joint length.

M Workmanship and Quality

M.1 Defective Pavement

The Department will pay for concrete pavement meeting the requirements and tolerances in accordance with this section at the Contract unit price. Pavement that fails to meet the minimum requirements when tested in the prescribed manner is considered defective. The Department may reject or adjust the payment for defective concrete pavement in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

The Engineer will determine the limits of each individual defective pavement area. If adjusting the price for defective payment, the Engineer will measure the area to the nearest whole square yard [square meter], except the Engineer will consider areas less than 1 sq. yd [1 sq. m] as 1 sq. yd [1 sq. m]. The Engineer will determine the condition of each individual defective area of pavement based on the calculation of greatest deficiency within the area.

M.2 Random or Uncontrolled Cracking

Repair or replace pavement with random or uncontrolled cracks as directed by the Engineer. If repairing the pavement as directed by the Engineer, use a dowel bar load transfer technique in accordance with the MnDOT Concrete Pavement Rehabilitation Details. Submit the intended repair technique to the Engineer for approval. Perform pavement repairs at no additional cost to the Department. If the repair fails, replace the pavement at no additional cost to the Department. The Engineer will accept repairs in accordance with 1516, "Acceptance."

M.3 Pavement Smoothness – IRI (International Roughness Index)

Provide concrete pavement smoothness in accordance with 2399, "Pavement Surface Smoothness."

N Thickness Requirements

Provide pavement with a finished pavement thickness as shown on the plans or as modified, in writing, by the Engineer.



N.1 Procedure

Construct pavement to the thickness shown on the plans. On each project and on each roadbed of a divided highway, evaluate pavement thickness in accordance with the following:

- (1) Contractor Quality Control Probing (QCP),
- (2) Probe Verification Core (PVC), and
- (3) Quality Acceptance Core (QAC).

The Department defines plan thickness lot (PTL) as concrete pavement of the same thickness added together lineally. Establish a separate PTL for each concrete plan thickness on the project.

The Department defines a subplot as the rate at which an individual measurement is taken over a given length. The Department considers a subplot as one lane wide, measured in accordance with the following:

- (1) From the pavement edge to the adjacent longitudinal joint;
- (2) From one longitudinal joint to the next;
- (3) In the absence of a longitudinal joint, between pavement edges; or
- (4) The Department considers a single lane to be each ramp and loop 18 ft [5.5 m] wide or less.

The Engineer will divide the PTL into sublots of 4,000 lineal lane ft [3,300 lineal lane m] to determine the QCP, PVC, and QAC locations. The Engineer will add partial sublots less than 2,000 ft [1,650 m] to the previous lot. The Engineer will consider partial sublots equal to or greater than 2,000 lineal lane ft [1,650 lineal lane m] as individual sublots. If the PTL for the entire project is less than 4,000 lineal lane ft [3,300 lineal lane m] the Engineer will consider the PTL as an individual subplot.

The Engineer will identify the QCP, PVC, and QAC thickness measurement locations in accordance with the following:

- (1) Determine the longitudinal locations using random numbers multiplied by length of the subplot;
- (2) Determine the transverse offset locations using a random number multiplied by the width of the traffic lane, ramp, or loop at the determined longitudinal location; and
- (3) Adjust the location to ensure the Contractor takes no measurements within 1 ft [0.3 m] of the pavement edge and takes no measurements within 2 ft [0.60 m] of any transverse or longitudinal joint or other obstructions.

N.2 Contractor Quality Control Probing (QCP)

Measure the pavement thickness of freshly finished concrete pavement at a rate of at least four QCP measurements per subplot. Notify the Engineer before performing probing thickness measurements in the plastic concrete so they may inspect or observe the Contractor's QCP tests during the paving operations.

Provide daily summary reports listing the results of the day's QCP thickness measurements and additional probing results to the Engineer.

N.3 Contractor QCP Probing Equipment and Probing Method

Provide the following equipment as approved by the Engineer to perform QCP probing:

- (1) Probing rod meeting the following characteristics and requirements:
 - (1.1) Non-flexing,
 - (1.2) Length capable of completely penetrating the pavement for measuring,
 - (1.3) Utilizes a circular or square top plate,
 - (1.4) Contains a centrally located hole in the top plate with a diameter allowing for easy maneuvering along the length of the probing rod, and
 - (1.5) Fitted with a locking device fixing the angle between the top plate and the probing rod at 90 degrees when locked.
- (2) Base plate meeting the following characteristics and requirements:
 - (2.1) 10.5 in [267 mm] square 26 gage galvanized steel plates or 11.8 in [295 mm] diameter 28 gage high-strength steel circular plates, and
 - (2.2) Rigid when in place, allowing the probing rod to be pushed against it without flexing.
- (3) Work bridge meeting the following characteristics and requirements:
 - (3.1) Spans the full width of the freshly laid concrete,
 - (3.2) Supports a person, and
 - (3.3) Height above the concrete allows for the use of the probing device.
- (4) Tape measure accurate to nearest $\frac{1}{8}$ in [even mm] and with a length capable of measuring the depth of penetration of the probing device into the plastic concrete pavement.

Perform probing in accordance with the following:

- (1) Place the base plates at the randomly selected locations and anchor the plates to prevent movement during concrete placement. Mark the locations of the base plates to ensure ease of locating the plates after the paver has passed.
- (2) Position the bridge at the selected locations to reach and locate each point.
- (3) Assemble the probing device. Keeping the probing rod perpendicular to the pavement surface, insert the rod into the plastic concrete until the rod strikes the base plate.
- (4) Slide the top plate down the probing rod until it contacts the pavement surface then lock to the probing rod.
- (5) Withdraw the probing device.
- (6) Measure the length of the probing rod inserted into the plastic concrete from the underside of the top plate to the end of the probing rod. Record this measurement to the nearest $\frac{1}{8}$ in [even mm].

N.4 Quality Acceptance Testing – Coring

The Engineer will measure the pavement thickness of concrete for each subplot in accordance with the following:

- (1) Probe Verification Core (PVC), and
- (2) Quality Acceptance Core (QAC).

The Engineer will mark one of every four QCP measurement locations per subplot for a PVC. The Engineer will mark one QAC per subplot.

The Contractor will core the designated PVC and QAC locations.



N.5 PVC and QAC Coring Method

- (1) Begin coring on concrete older than 7 days, when the control beams attain a flexural strength in accordance with Table 2301-1, or when the control cylinders attain a compressive strength of 3,000 psi [20.6 MPa]. Use 3U18 concrete or another concrete mix approved by the Engineer to fill the core holes within 72 h of coring at no additional cost to the Department. Provide traffic control for coring;
- (2) Cut 4 in [100 mm] nominal diameter cores at marked locations. Lay the cores next to the holes in a curing condition. Protect the cores. Do not submit cores out of round, not perpendicular, or containing ridges;
- (3) The Engineer will field measure the core thickness to the nearest $\frac{1}{8}$ in [even mm], verify (Field ID Number) the cores, and record the field measurement on MnDOT Form 24327, "Field Core Report," or a computerized spreadsheet available on the MnDOT Concrete Engineering website;
- (4) Pick up the cores, accompanied by the Engineer. Store the cores in a water tank heated from 60 °F to 80 °F [15 °C to 25 °C] at the Department field office. The Engineer will not require the storage of cores in a curing condition for concrete older than 28 days;
- (5) The Engineer will transport the cores in a curing condition, unless older than 28 days, to the MnDOT Office of Materials and Road Research; and
- (6) The MnDOT Office of Materials and Road Research will determine the pavement thickness by measuring the length of the PVC and QAC cores in accordance with the procedure on file at the MnDOT Office of Materials and Road Research. Following this procedure, the MnDOT Office of Materials and Road Research will use nine probes interconnected in a hydraulic linkage to obtain the average length of the core in one operation. The MnDOT Office of Materials and Road Research will record the core length to the nearest 0.05 in [1 mm].

N.6 Non-conforming thickness

The Department will base acceptance of the pavement thickness and price adjustment for deficient thickness on the combination of both lab measured PVC and QAC coring.

The Department defines the tolerance limit for pavement thickness as the plan thickness lot (PTL) minus $\frac{1}{2}$ in [13 mm]. If the QCP measurement shows a thickness deficiency greater than PTL minus $\frac{1}{2}$ in [13 mm], take a core at the location of the deficient QCP. If any core thickness measurement (PVC or QAC) shows a thickness deficiency greater than PTL minus $\frac{1}{2}$ in [13 mm], consider the pavement defective and take exploratory cores as directed by the Engineer.

The Department defines the defective pavement area as the entire area surrounding the deficient core within a traffic lane and between acceptable cores. The Department considers the pavement acceptable in the remaining areas as the increment where the cores show a thickness deficiency no greater than PTL minus $\frac{1}{2}$ in [13 mm].

Take the first exploratory cores at any location within 10 ft [5 m] on each side of the deficient thickness location and at the same distance from the pavement centerline. Take an additional exploratory core in the adjacent traffic lane if the concrete was placed in the same operation. If the length of each of the first exploratory cores is at least equal to the PTL minus $\frac{1}{2}$ in [13 mm], the Engineer will not require additional cores from this location. If any cores do not fall within the PTL minus $\frac{1}{2}$ in [13 mm], take additional exploratory cores at 25 ft [10 m] intervals and at the same distance from the pavement

centerline in the same lane as the original thickness measurement, as directed by the Engineer. Perform coring in the direction of the deficiency until obtaining a core with a length at least equal to the PTL minus $\frac{1}{2}$ in [13 mm]. The Engineer will use exploratory cores to determine the extent of deficient pavement thickness for adjusting the Contract unit price or requiring pavement removal and replacement.

For cores showing a pavement thickness greater than the PTL minus $\frac{1}{2}$ in to 1 in [13 mm to 25 mm], the Contractor may choose one of the following:

- (1) Remove and replace the defective pavement area at no additional cost to the Department, or
- (2) Leave the pavement in place with a monetary deduction of \$20 per sq. yd [\$25 per sq. m] for the defective pavement area, as approved by the Engineer.

For cores showing a pavement thickness greater than PTL minus 1 in [25 mm], the Engineer, in conjunction with the Concrete Engineer, will determine whether the Contractor will remove and replace concrete pavement or leave the pavement in place at no cost to the Department and apply a monetary deduction of \$20 per sq. yd [\$25 per sq. m] for the defective pavement area in accordance with 1503, "Conformity with Contract Documents."

The Engineer will use the PVC and QAC cores to determine the final average plan thickness lot (PTL), except for the following:

- (1) If exploratory cores are taken to identify the defective pavement area, substitute the two outside exploratory cores that are within PTL minus $\frac{1}{2}$ in [13 mm] for the deficient PVC or QAC.
- (2) If the length of a PVC or QAC exceeds the PTL plus 0.30 in [8 mm], the Engineer will limit the core length to the PTL plus 0.30 in [8 mm].

The Engineer will consider the pavement thickness as conforming provided the deficiency of the final average PTL does not exceed PTL minus 0.10 in [3 mm].

If the final average PTL is deficient by more than the PTL minus 0.10 in [3 mm], the Department will pay for the pavement in the PTL at the Contract unit price less the monetary deductions in Table 2301-14, excluding areas of defective pavement:

Table 2301-14	
Deductions for Thickness Deficiencies	
Thickness Deficiency Exceeding Permissible Deviations, in [mm]	Adjusted Contract unit price per sq. yd [sq. m] of Payment
0.00 – \leq 0.10 [\leq 3]	None (tolerance)
0.10 – \leq 0.20 [3 – \leq 5]	\$0.20 [\$0.25]
0.20 – \leq 0.30 [5 – \leq 8]	\$0.40 [\$0.50]
0.30 – \leq 0.40 [8 – \leq 10]	\$0.70 [\$0.90]
0.40 – \leq 0.50 [10 – \leq 13]	\$1.00 [\$1.25]
0.50 – \leq 1.00 [13 – \leq 25]*	\$20.00 [\$25.00]
* Perform exploratory coring as required by the Engineer.	

After Department thickness verification, the Department will test all of the cores for compressive strength at 60 days of age. The Department will test three of the cores from the entire project for rapid chloride permeability (RCP) in lieu of compressive strength testing for information only.



O Opening Pavement to Traffic

Do not open a new pavement slab to general public traffic or operate paving or other heavy equipment on it for 7 days, or until the concrete has reached a minimum flexural strength meeting the requirements of Table 2301-15, or minimum compressive strength of 3,000 psi [20.6 MPa]; whichever occurs first.

If the pavement joints are widened, seal the joints before operating paving or other heavy equipment and general public traffic on the pavement.

Cast the control specimens in accordance with 2461.3.G.5, "Test Methods and Specimens." Cure the control specimens in the same manner and under the same conditions as the pavement represented. The Engineer will test the control specimens in accordance with 2461.3.G.5, "Test Methods and Specimens."

Table 2301-15	
Minimum Strength Requirements for Opening Pavements to Construction and to General Public Traffic	
Slab Thickness, in [mm]	Flexural Strength, psi [MPa]
≤7.0 [175]	500 [3.4]
7.5 [190]	480 [3.3]
8.0 [200]	460 [3.2]
8.5 [215]	440 [3.0]
9.0 [225]	390 [2.7]
≥ 9.5 [240]	350 [2.4]

Perform operations on new pavement as approved by the Engineer and in accordance with the following:

- (1) When moving on and off the pavement, construct a ramp to prevent damage to the pavement slab.
- (2) Operate the paving equipment on protective mats to prevent damage to the pavement surface and joints. Before placing the protective mats, sweep the pavement surface free of debris.
- (3) Operate equipment on a slab without causing damage. If damage results, suspend operations and take corrective action as approved by the Engineer. Do not operate the equipment wheels or tracks within 4 in [100 mm] of the slab edge.

2301.4 METHOD OF MEASUREMENT

A Concrete Pavement

If the Contract includes the Contract item *Concrete Pavement* or *Concrete Pavement High Early*, the Engineer will measure in accordance with the following:

- (1) Measure the concrete pavement placed to a uniform cross-section thickness by the surface area of the pavement as constructed, including integrant curb;
- (2) Verify the pavement thickness based on the final measurement of cores;

- (3) Include measurements for concrete pavement without regard to grade, strength, or type of concrete, width, or thickness of the pavement in a single measurement, except if the plans include a Contract item for high-early strength concrete; and
- (4) Apply incentive or disincentive for *Concrete Pavement* based on the theoretical volume of concrete used by multiplying the measured square yard [square meter] of concrete by the thickness shown on the plans.

B Place Concrete Pavement

If the Contract includes the Contract item *Place Concrete Pavement*, the Engineer will measure in accordance with the following:

- (1) Measure concrete pavement placed to a variable cross-section thickness by area based on specified dimensions, including integrant curb. This measurement will represent the surface area of the pavement as constructed.
- (2) Verify the pavement thickness based on the lab measured cores.

B.1 Structural Concrete

If the Contract includes the Contract item *Structural Concrete* or *Structural Concrete High Early*, the Engineer will measure in accordance with the following:

- (1) Measure structural concrete placed to a variable cross-section thickness by volume.
- (2) Verify the volume measurements from the computerized batch ticket printouts from the plant, as verified by cement cutoffs and the consideration of any waste.
- (3) Include the volume of all specified concrete pavements into a single item without regard to grade, strength, width, or thickness of the concrete pavement, except if the plans include a Contract item for high-early strength concrete.
- (4) Apply incentives or disincentives for *Structural Concrete* based on the cubic yard [cubic meter].

C Supplemental Pavement Reinforcement

The Engineer will measure supplemental pavement reinforcement over culverts, storm sewers, and water mains, by weight.

D Expansion Joints

The Engineer will separately measure dowelled expansion joints of each design designation as shown on the plans by length along the joint line.

E Reinforcement Bars

The Engineer will not separately measure keyway bars, tie bars, taper steel, stopper bars, and other reinforcement bars.

F Integrant Curb



The Engineer will separately measure integral curb of each design by length.

G Dowel Bars

The Engineer will measure dowel bars by the actual number of individual dowels placed. The Engineer will not measure dowels included in the Contract linear foot [meter] price for *Dowelled Expansion Joints, Design ____*.

H Concrete Coring

The Engineer will not separately measure the number of cores taken, identified, and delivered as required by the Contract or directed by the Engineer.

2301.5 BASIS OF PAYMENT

A Concrete Pavement

Unless the plans include a separate Contract item for work incidental to *Concrete Pavement*, the Contract square yard [square meter] price for *Concrete Pavement* includes the cost of constructing the pavement, including the cost of batch materials and mixing operations; plant-lab office; producing the concrete; fine grading; forming, including all headers; providing and installing keyway and keyway bars, tie bars, taper steel, stopper bars, and other reinforcement bars; delivering; depositing; placing; spreading; screeding; vibration monitoring; finishing; curing; protecting; sawing; and sealing the concrete.

If the plans include a separate Contract item for *Concrete Pavement High-Early* or if the Contractor requests high-early and the Engineer approves, the Department will not provide extra compensation for the production of high-early strength concrete. The Contract square yard [square meter] price for *Concrete Pavement High-Early* includes the cost of constructing the pavement, including the cost of batch materials and mixing operations; plant-lab office; producing the concrete; fine grading; forming, including all headers; providing and installing keyway bars, tie bars, taper steel, stopper bars, and other reinforcement bars; delivering; depositing; placing; spreading; screeding; vibration monitoring; finishing; curing; and protecting the concrete.

If the plans do not include a separate Contract item for *Concrete Pavement High-Early* and the Engineer orders high-early concrete, the Department will pay for the additional cement at a rate of the invoice cost plus 15 percent.

B Place Concrete Pavement

Unless the plans include a separate Contract item for work incidental to *Place Concrete Pavement*, the Contract square yard [square meter] price for *Place Concrete Pavement* includes the cost of constructing the pavement, including fine grading; forming, including all headers; providing and installing keyway and keyway bars, tie bars, taper steel, stopper bars, and other reinforcement bars; placing; spreading; screeding; vibration monitoring; finishing; curing; protecting; sawing; and sealing the concrete.

B.1 Structural Concrete

The Engineer will field calculate the volume of *Structural Concrete* and *Structural Concrete High Early* placed. Due to variations in the asphalt or asphalt bond breaker layer, the Contractor may request additional volume up to 102 percent of the Engineer's field calculated final volume of *Structural Concrete*, *Structural Concrete High Early*, or both for the entire project. The Engineer will verify additional volume of concrete from the computerized batch ticket printouts from the plant, with consideration of any waste. If the Engineer finds the Contractor's request for the additional final volume valid, the Engineer will pay for the additional volume up to 102 percent of the calculated quantity for the entire project. The Contract cubic yard [cubic meter] price for *Structural Concrete* and *Structural Concrete High-Early* includes the cost of producing, delivering, and depositing the concrete, including the cost of the batch materials, mixing operations, and the plant-lab office. If the plans include a separate Contract item for *Structural Concrete High-Early* or if the Contractor requests high-early and the Engineer approves, the Department will not provide extra compensation for the production of high-early strength concrete.

If the plans do not include a separate Contract item for *Structural Concrete High-Early* and the Engineer orders high-early concrete, the Department will pay for additional cement at a rate of the invoice cost plus 15 percent.

C Other Concrete Items

The Contract pound [kilogram] price for *Supplemental Pavement Reinforcement* includes the cost of providing and placing the metal reinforcement, including tie wires, supporting devices, and splicing.

The Contract linear foot [meter] price for *Dowelled Expansion Joints, Design ____* includes the cost of constructing the joints complete in place as shown on the plans, including the costs of providing and placing dowel bar assemblies, filler, and sealer materials.

The Contract linear foot [meter] price for *Integrand Curb, Design ____* includes the cost of forming and finishing the curb and protecting and curing the concrete.

The relevant Contract unit price for *Concrete Pavement* or *Place Concrete Pavement* includes the cost of coring, including the cost of material, labor, equipment, delivery, core hole filling, and traffic control.

The Department will pay for concrete pavement on the basis of the following schedule:

Item No.:	Item:	Unit:
2301.604	Concrete Pavement ____ in [____ mm]	square yard [square meter]
2301.604	Concrete Pavement ____ in [____ mm] High-Early	square yard [square meter]
2301.604	Place Concrete Pavement ____ in [____ mm]	square yard [square meter]
2301.511	Structural Concrete	cubic yard [cubic meter]
2301.513	Structural Concrete High-Early	cubic yard [cubic meter]
2301.608	Supplemental Pavement Reinforcement	pound [kilogram]
2301.603	Dowelled Expansion Joints, Design ____	linear foot [meter]
2301.538	Dowel Bar	each
2301.541	Integrand Curb, Design ____	linear foot [meter]



(2360) PLANT MIXED ASPHALT PAVEMENT (2013 VERSION)

January 23, 2013

2360.1 DESCRIPTION

This work consists of constructing plant mixed asphalt pavement on a prepared surface.

Plant mixed asphalt pavement designed according to a gyratory mix design method for use as a pavement surface.

A Mixture Designations

The Department will designate the mixture for asphalt mixtures in accordance with the following:

- (1) The first two letters indicate the mixture design type:
 - (1.1) SP = Gyratory Mixture Design.
- (2) The third and fourth letters indicate the course:
 - (2.1) WE = Wearing and shoulder wearing course, and
 - (2.2) NW = Non-wearing Course.
- (3) The fifth letter indicates the maximum aggregate size:
 - (3.1) A = ½ in [12.5mm], SP 9.5,
 - (3.2) B = ¾ in [19.0mm], SP 12.5,
 - (3.3) C = 1 in [25.0mm], SP 19.0, and
 - (3.4) D = ¾ in [9.5mm], SP 4.75.
- (4) The sixth digit indicates the Traffic Level (ESAL's $\times 10^6$) in accordance with Table 2360-1, "Traffic Levels."

Table 2360-1 Traffic Levels	
Traffic Level	20 Year Design ESALs
2 *	< 1
3	1 – < 3
4	3 – < 10
5	10 – ≤ 30
6	>30 (See SMA Provision)
NOTE: The requirements for gyratory mixtures in this specification are based on the 20 year design traffic level of the project, expressed in Equivalent Single Axle Loads (ESAL's) 1×10^6 ESALs	
* AADT < 2,300	
AADT > 2,300 to < 6,000	

- (5) The last two digits indicate the air void requirement:
- (5.1) 40 = 4.0 percent for wear mixtures, and
- (5.2) 30 = 3.0 percent for non-wear and shoulder.
- (6) The letter at the end of the mixture designation identifies the asphalt binder grade in accordance with Table 2360-2, "Asphalt Grades."

Table 2360-2 Asphalt Grades	
Letter	Grade
A	PG 52 – 34
B	PG 58 – 28
C	PG 58 – 34
E	PG 64 – 28
F	PG 64 – 34
H	PG 70 – 28
I	PG 70 – 34
L	PG 64 – 22
M	PG 49 – 34

Ex: Gyratory Mixture Designation -- SPWEB540E (Design Type, Lift, Aggr. Size, Traffic Level, Voids, Binder)

2360.2 MATERIALS

A Aggregate

Use aggregate materials in accordance with 3139.2.

BAsphalt Binder Material3151

C Additives

The Department defines additives as material added to an asphalt mixture or material that does not have a specific pay item.

Do not incorporate additives into the mixture unless approved by the Engineer. Add anti-foaming agents to asphalt cement at the dosage rate recommended by the manufacturer. The Contractor may add mineral filler in quantities no greater than 5 percent of the total aggregate weight. The Contractor may add hydrated lime in quantities no greater than 2 percent of the total aggregate weight. Do not add a combination of mineral filler



and hydrated lime that exceeds 5 percent of the total aggregate weight. Use methods for adding additives as approved by the Engineer.

C.1Mineral Filler
..... AASHTO M 17

C.1.a Mineral Filler – Hydrated Lime

Provide hydrated lime for asphalt mixtures with no greater than 8 percent unhydrated oxides (as received basis) and meeting the requirements of AASHTO M 216. Use a method to introduce and mix hydrated lime and aggregate as approved by the Engineer before beginning mixture production.

C.2 Liquid Anti-Stripping Additive (Contractor Added)

If adding a liquid anti-strip additive to the asphalt binder, complete blending before mixing the asphalt binder with the aggregate. Only use liquid anti-strip additives that ensure the asphalt binder meets the Performance Grade (PG) requirements in 3151. The Contractor may use asphalt binder with liquid anti-strip added at the refinery or the Contractor may add liquid anti-strip at the plant site. If using asphalt binder with liquid anti-strip added at the refinery, ensure the supplier tests the binder and additive blend to confirm compliance with the AASHTO M 320. If an anti-strip agent is added at the plant, the plant mixed asphalt producer is considered a supplier and the binder must conform to the requirements of 3151. Do not pave until the asphalt binder and additive blend testing results meet the criteria in 2360.2.B, “Asphalt Binder Material.”

C.2.a Mixture Requirements at Design

Design the mixture with the same asphalt binder supplied to the plant site using mixture option 1, “Laboratory Mixture Design” or mixture option 2, “Modified Mixture Design.”

Provide documentation with either design option and include the amount of anti-strip needed to meet the minimum tensile strength requirements. Verify that the binder with the anti-strip meets the PG binder requirements for the mixture.

C.2.b Contractor Production Testing Requirements

Sample and test the asphalt binder and anti-strip blend daily. The Contractor may test the blend by viscosity, penetration, or dynamic shear rheometer (DSR) of the blend. If the contract requires the use of a polymer modified asphalt binder in the mixture, use the DSR as the daily QC test.

Send the Engineer and MnDOT Chemical Laboratory Director a weekly QC report summarizing the results of the daily testing.

Perform at least one test bi-weekly per project to ensure the binder and anti-strip blend meets the requirements of AASHTO M 320. Send the test results to the Engineer and MnDOT Chemical Laboratory Director.

Provide asphalt binder and anti-strip blend field verification samples in accordance with 2360.2.G.7, "Production Test."

C.2.c Liquid Anti-Strip Additive Metering System

Include a liquid anti-strip flow meter and an anti-strip pump with the metering system. Connect the flow meter to the liquid anti-strip supply to measure and display only the anti-strip being fed to the asphalt binder.

Position the meter readout so that the inspector can easily read it.

Provide means to compare the flow meter readout with the calculated output of the anti-strip pump.

Provide a system that displays the accumulated anti-strip quantity being delivered to the mixer unit in gallons [liters] to the nearest gallon [liter] or in units of tons [metric tons] to the nearest 0.001 ton [0.001 tonne].

Calibrate and adjust the system to maintain an accuracy of ± 1 percent.

Calibrate each plant set-up before producing the mixture.

"Stick" the anti-strip tank at the end of the day's production to verify anti-strip usage quantities. The Engineer may require "sticking" on a daily basis.

Ensure the system has a spigot for sampling the binder and anti-strip after blending.

Use alternative blending and metering systems only when pre-approved by the Engineer.

C.3 Coating and Anti Stripping Additive3161

C.4 Warm Mix Asphalt (WMA)

WMA is allowed on all projects. Any mix that is produced at temperatures 30°F or lower than typical HMA mixing temperature of the asphalt binder, as defined by the asphalt supplier, is considered as WMA. The WMA can be manufactured through use of foamed asphalt and/or chemical additive processes. Notify the Engineer in advance of using any WMA additive or process. When chemical additives are used, provide the plant mixing and the laboratory mixing and compaction temperatures as recommended by the manufacturer of the additive.

D Bituminous Tack Coat2357



E Mixture Design

E.1 Submittal Location

Submit documentation and sample aggregate materials for review to the District Materials Laboratory.

E.2 Aggregate Quality

Provide aggregate in accordance with 3139.2.

E.3 Restrictions

Do not add aggregates and materials not included in the original mixture submission unless otherwise approved by the Engineer.

E.4 Responsibility

Design a gyratory mixture that meets the requirements of this specification in accordance with the following:

- (1) MnDOT Laboratory Manual Method 1820,
- (2) The Asphalt Institute's Superpave Mix Design Manual SP-2 (Use a 2 h short term aging period for volumetric), and
- (3) The Laboratory Manual.

E.5 Type of Mixture Design Submittal

E.5.a Option 1 — Laboratory Mixture Design

E.5.a(1) Aggregate

Submit the aggregate samples for option 1, at least 15 working days before beginning production samples for quality testing. At least 30 calendar days before beginning asphalt production, submit samples of aggregates that require the magnesium sulfate soundness test to the District Materials Laboratory. Test the samples for quality of each source, class, type, and size of virgin and non-asphaltic salvage aggregate source used in the mix design. Retain a companion sample of equal size until the Department issues a Mixture Design Report. Provide 24 h notice of intent to sample aggregates to the Engineer. Provide samples in accordance with the following:

<p style="text-align: center;">Table 2360-4 Aggregate Sample Size</p>

Classification	Sieve	Weight
Virgin	Retained on No. 4 [4.75 mm]	80 lb [35 kg]
Virgin	Passing No. 4 [4.75 mm]	35 lb [15 kg]
Recycled asphalt pavement (RAP)	—	80 lb [35 kg]
Recycled asphalt shingles (RAS)	—	10 lb [5 kg] sample of representative RAS material

E.5.a(2) Mixture Sample

At least 7 working days before the start of asphalt production, submit the proposed Job Mix Formula (JMF) in writing and signed by a Level II Quality Management mix designer for each combination of aggregates to be used in the mixture. Include test data to demonstrate conformance to mixture properties as specified in Table 2360-7, "Mixture Requirements," and 3139.2, "Bituminous Aggregates." Use forms approved by the Department for the submission.

Submit an uncompacted mixture sample plus briquettes, in conformance with the JMF, compacted at the optimum asphalt content and required compactive effort for laboratory examination and evaluation. Provide a mixture sample size and the number of compacted briquettes and in accordance with the following:

Table 2360-5 Mixture Sample Requirements	
Item	Gyratory Design
Uncompacted mixture sample size	75 lb [30 kg]
Number of compacted briquettes	2

E.5.a(3) Tensile Strength Ratio Sample

At least 7 days before actual production, submit sample to the District Materials Laboratory for verification of moisture sensitivity retained tensile strength ratio (TSR). The Engineer may test material submitted for TSR verification for maximum specific gravity G_{mm} compliance in addition to TSR results. The Engineer will reject the submitted mix design if the tested material fails to meet the G_{mm} tolerance. If the Engineer rejects a mix design, submit a new mix design in accordance with 2360.2.E, "Mixture Design." The Contractor may use one of the following options to verify that the TSR meets the requirements in Table 2360-7, "Mixture Requirements."

E.5.a(4) Option A

Batch material at the design proportions including optimum asphalt. Split the sample before curing and allow samples to cool to room temperature, approximately 77 °F [25 °C]. Submit 80 lb [35 kg] of mixture to the District Materials Laboratory for curing and test verification. Use a cure time of 2 h ±15 minutes at 290 °F [144 °C] cure time for both groups and follow procedures Laboratory Manual Method 1813.



E.5.a(5) Option B

Batch and cure in accordance with Option A. Compact, and submit briquettes and uncompacted mixture in accordance with Table 2360-6, "Option B Mixture Requirements."

Table 2360-6	
Option B Mixture Requirements	
Item	Gyratory Design
Un-compacted mixture sample size	8,200 g
Number of compacted briquettes*	6
Compacted briquette air void content	6.5 % – 7.5 %
* 6 in [150 mm] specimens.	

For both options, cure for 2 h \pm 15 min at 290° F [144° C] meeting the requirements in the MnDOT Laboratory Manual Method 1813.

E.5.a(6) Aggregate Specific Gravity

Determine the specific gravity of aggregate in accordance with Laboratory Manual Methods 1204 and 1205.

E.5.b Option 2 — Modified Mixture Design

The Contractor may use the modified mixture design if testing shows that the aggregates meet the requirements of 3139.2 in the current construction season and if the Level II mix designer submitting the mixture design has at least 2 years experience in mixture design. The Department will not require mixture submittal.

E.5.b(1) Mixture Aggregate Requirements

Size, grade, and combine the aggregate fractions in proportions that are in accordance with 3139.2.

E.5.b(2) JMF Submittal

At least 2 working days before beginning asphalt production, submit a proposed JMF in writing to the District Materials Laboratory signed by a Level II Quality Management mix designer for each combination of aggregates. For each JMF submitted, include documentation in accordance with 2360.2.E.5.a, "Option 1 – Laboratory Mixture Design," to demonstrate conformance to mixture properties as specified in Table 2360-7, "Mixture Requirements," and Table 3139-3, "Mixture Aggregate Requirements." Submit the JMF on forms approved by the Department.

E.5.b(3) Initial Production Test Verification

The Department will take a mix verification sample within the first four samples at the start of production of each mix type. The Engineer will notify the Contractor electronically when a sample is to be taken and tested for tensile strength ratio (TSR). Initial production testing will be done within the first 5,000 tons [4500 tonnes] of the start of production.

E.6 Mixture Requirements

The Department will base mixture evaluation on the trial mix tests and in accordance with Table 2360-7, "Mixture Requirements."

Table 2360-7				
Mixture Requirements				
Traffic Level	2	3	4	5
20 year design ESALs	< 1 million	1 – 3 million	3 – 10 million	10 – 30 million
Gyratory mixture requirements:				
Gyrations for N_{design}	40	60	90	100
% Air voids at N_{design} , wear	4.0	4.0	4.0	4.0
% Air voids at N_{design} , Non-wear and all shoulder	3.0	3.0	3.0	3.0
Adjusted Asphalt Film Thickness, minimum μ	8.5	8.5	8.5	8.5
TSR*, <i>minimum %</i>	75 \parallel	75 \parallel	80 \uparrow	80 \uparrow
Fines/effective asphalt	0.6 – 1.2	0.6 – 1.2	0.6 – 1.2	0.6 – 1.2
* Use 6 in [150 mm] specimens in accordance with 2360.2.I, "Field Tensile Strength Ratio (TSR)." \parallel MnDOT minimum = 65 \uparrow MnDOT minimum = 70				

E.7 Minimum Ratio of Added Asphalt Binder to Total Asphalt Binder

Control recycled materials used in mixture by evaluating the ratio of new added asphalt binder to total asphalt binder as show in Table 2360-8.



Table 2360-8 Requirements for Ratio of Added New Asphalt Binder to Total Asphalt Binder¹ min%:			
Specified Asphalt Grade ²	Recycled Material		
	RAS Only	RAS + RAP	RAP Only
PG XX-28, PG 52-34, PG 49-34, PG 64-22			
Wear	70	70	70
Non-Wear	70	70	65
PG 58-34, PG 64-34, PG 70-34			
Wear & Non-Wear	80	80	80
<p>1. ¹ The ratio of added new asphalt binder to total asphalt binder is calculated as (added binder/total binder) x 100</p> <p>2. ² The Contractor can elect to use a blending chart to verify compliance with the specified binder grade. The Department may take production samples to ensure the asphalt binder material meets the requirements. The blending chart is on the Bituminous Office Website.</p>			

E.8Adjusted Asphalt Film Thickness (Adj. AFT)
.....MnDOT Laboratory Manual Method 1854

Ensure the adjusted asphalt film thickness (Adj. AFT) of the mixture at design and during production meets the requirements of Table 2360-7, "Mixture Requirements." Base the Adj. AFT on the calculated aggregate surface area (SA) and the effective asphalt binder content.

E.9 Documentation

Include the following documentation and test results with each JMF submitted for review:

- (1) Names of the individuals responsible for the QC of the mixture during production,
- (2) Low project number of the contract on which the mixture will be used,
- (3) Traffic level and number of gyrations,
- (4) The following temperature ranges as supplied by the asphalt binder supplier:
 - (4.1) Laboratory mixing and compaction,
 - (4.2) Plant discharge, and
 - (4.3) Field compaction.
- (5) The percentage in units of 1 percent (except the No. 200 sieve [0.075 mm] in units of 0.1 percent) of aggregate passing each of the specified sieves (including the No. 16, No. 30, No. 50, and No. 100) for each aggregate to be incorporated into the mixture. Derive the gradation of the aggregate from the RAP after extracting the residual asphalt.
- (6) Source descriptions of the following:
 - (6.1) Location of material,
 - (6.2) Description of materials,
 - (6.3) Aggregate pit or quarry number, and

-
- (6.4) Proportion amount of each material in the mixture in percent of total aggregate.
 - (7) Composite gradation based on (5) and (6) above. Include virgin composite gradation based on (6) and (7) above for mixtures containing RAP/RAS.
 - (8) Bulk and apparent specific gravities and water absorption (by % weight of dry aggregate). Both coarse and fine aggregate, for each product used in the mixture (including RAP/RAS). Use MnDOT Laboratory Manual Method 1204 and 1205. The tolerance allowed between the Contractor's and the Department's specific gravities are G_{sb} (individual) = 0.040 [+4 and -4] and G_{sb} (combined) = 0.020.
 - (9) FHWA 0.45 power chart represented by the composite gradation plotted on Federal Form PR-1115
 - (10) Test results from the composite aggregate blend at the proposed JMF proportions showing compliance with Table 3139-3:
 - (10.1) Coarse Aggregate Angularity,
 - (10.2) Fine Aggregate Angularity, and
 - (10.3) Flat and Elongated
 - (11) Extracted asphalt binder content for mixtures containing RAP/RAS with no retention factor included.
 - (12) Asphalt binder percentage in units of 0.1 percent based on the total mass of the mixture and the PG grade.
 - (13) Each trial mixture design includes the following:
 - (13.1) At least 3 different asphalt binder contents (with at least 0.4 percent between each point), with at least one point at, one point above and one point below the optimum asphalt binder percentage.
 - (13.2) Maximum specific gravity for each asphalt binder content calculated based on the average of the effective specific gravities measured by using at least two maximum specific gravity tests at the asphalt contents above and below the expected optimum asphalt binder content.
 - (13.3) Test results on at least two specimens at each asphalt binder content for the individual and average bulk specific gravities, density, and heights.
 - (13.4) Percent air voids of the mixture at each asphalt binder content.
 - (13.5) Adj. AFT for each asphalt binder content.
 - (13.6) Fines to Effective Asphalt (F/A) ratio calculated to the nearest 0.1 percent.
 - (13.7) TSR at the optimum asphalt binder content.
 - (13.8) Graphs showing air voids, adjusted AFT, G_{mb} , G_{mm} and unit weight vs. percent asphalt binder content for each of the three asphalt binder contents submitted with trial mix.
 - (13.9) Evidence that the completed mixture will conform to design air voids (V_a), Adj. AFT, TSR, F/A_e (Fines to effective asphalt ratio).
 - (13.10) Gyratory densification tables and curves generated from the gyratory compactor for all points used in the mixture submittal.
 - (13.11) % new asphalt binder to total asphalt binder.
 - (14) The Contractor has the option of augmenting the submitted JMF with additional sand or rock. When using this option, provide samples of the aggregate for quality analysis in accordance with 2360.2.E.5, "Type of Mixture Design Submittal." Also provide mix design data for two additional design points per add-material. Provide one point to show a proportional adjustment to the submitted JMF that includes 5 percent, by weight, add-
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material at the JMF optimum asphalt percent. Provide a second point to show a proportional adjustment to the submitted JMF that includes 10 percent, by weight, add material at the JMF optimum asphalt percent. Report the following information for each of these two points:

- (14.1) The maximum specific gravity determined by averaging two tests,
- (14.2) Test results showing the individual and average bulk specific gravity, density, and height of at least two specimens at the optimum asphalt binder content,
- (14.3) Percent air voids for the mixture for each point,
- (14.4) Fines to Effective Asphalt ratio calculated to the nearest 0.1 of a percent,
- (14.5) Crushing of the coarse and fine aggregate,
- (14.6) Adj. AFT, and,
- (14.7) Up to two add materials will be allowed.

F Mixture Design Report

The Department will provide a Mixture Design Report consisting of the JMF. Include the following in the JMF:

- (1) Composite gradation,
- (2) Aggregate component proportions,
- (3) Asphalt binder content of the mixture,
- (4) Design air voids,
- (5) Adj. asphalt film thickness, and
- (6) Aggregate bulk specific gravity values.

Show the JMF limits for gradation control sieves in accordance with aggregate gradation broadbands shown in Table 3139-2, percent asphalt binder content, air voids, and Adj. AFT. If the Department issues a Mixture Design Report, this report only confirms that the Department reviewed the mixture and that it meets volumetric properties shown in Table 2360-7 and Table 2360-8. The Department makes no guaranty or warranty, either express or implied, that compliance with volumetric properties ensures specification compliance regarding placement and compaction of the mixture.

Provide materials meeting the requirements of the aggregate and mixture design before issuing a Mixture Design Report. The Department will review two trial mix designs per mix type designated in the plan per contract at no cost to the Contractor. The Department will verify additional mix designs at a cost of \$2,000 per design.

Provide a Department - reviewed Mixture Design Report for all paving except for small quantities of material as described in 2360.3.G, "Small Quantity Paving."

For city, county, and other agency projects, provide the District Materials Laboratory a complete project proposal, including addenda, supplemental agreements, change orders, and plans sheets, including typical sections, affecting the mix design before the Department begins the verification process.

G Mixture Quality Management

G.1 Quality Control (QC)

The Contractor will perform Quality Control (QC) as part of the production process. QC is the process control of the operations related to mixture production and determining the quality of the mixture being produced. The QC sample is the Contractor's sample taken and tested during production and used to control the production process. Provide and maintain a QC program for plant mix asphalt production, including mix design, process control inspection, sampling and testing, and adjustments in the process related to the production of an asphalt pavement.

G.1.a Certification

Provide the following to obtain certification:

- (1) Completed and submitted request form application for plant inspection.
- (2) Site map showing stockpile locations.
- (3) Signed asphalt plant inspection report showing the plant and testing facility passed as documented by Asphalt Plant Inspection Report (TP 02142-02, TP 02143-02). The inspection report must also include documentation showing plant and laboratory equipment has been calibrated and is being maintained to the tolerance shown in the Bituminous Manual and sections 1200, 1800, and 2000 of the MnDOT Laboratory Manual.
- (4) A Department-signed Mixture Design Report (MDR) before mixture production.

G.1.b Maintaining Certification

Maintain plant certification by documenting the production and testing of the certified plant asphalt mixtures. Sample and test asphalt mixtures in accordance with this section and meeting the requirements of the Schedule of Materials Control.

G.1.b(1) Annual Certification

Perform annual certification after winter suspension.

G.1.b(2) Sampling Rate

Sample at the rate in accordance with 2360.2.G.6 and the requirements of the Schedule of Materials Control.

G.1.b(3) Plant Moved

Recertify the plant if the plant moves to a new or previously occupied location.



G.1.c. Plant Certification Revocation

The Engineer may revoke certification for any of the following reasons:

- (1) If the mix does not meet the requirements of 2360.2.E.6, 2360.2.E7, and 3139.2,
- (2) If there is a failure to meet the testing rates, or
- (3) If it is determined records were falsified.

If the Engineer revokes plant certification, the Department may revoke the Technical Certification of the individual or individuals involved. The Department will maintain a list of companies with revoked certifications.

G.2 Quality Assurance (QA)

The Engineer will perform Quality Assurance (QA) as part of the acceptance process. QA is the process of monitoring and evaluating various aspects of the Contractor's testing as described below. The QA sample is the Department's companion sample to the Contractor's QC sample. QA testing is performed to accept the work. The Engineer will perform the following:

- (1) Conduct QA and verification sampling and testing,
- (2) Observe the QC sampling and tests,
- (3) Monitor the required QC summary sheets and control charts,
- (4) Verify calibration of QC laboratory testing equipment,
- (5) Communicate Department test results to the Contractor's personnel on a daily basis, and
- (6) Ensure Independent Assurance (IA) sampling and testing requirements are met.

If the Engineer observes that the Contractor is not performing sampling and quality control tests in accordance with the applicable test procedures, the Engineer may stop production until the Contractor takes corrective action. The Engineer will notify the Contractor of observed deficiencies promptly, both verbally and in writing.

The Engineer may obtain additional samples, at any time and location during production, to determine quality levels in accordance with 2360.2.G.3, "Verification Sample."

The Department will post a chart with the names and telephone numbers for the personnel responsible for QA.

The Engineer will calibrate and correlate laboratory testing equipment in accordance with the Bituminous Manual and Laboratory Manual.

Table 2360-9	
Allowable Differences between Contractor and Department Test Results*	
Item	Allowable Difference
Mixture bulk specific gravity (Gmb)	0.030

Table 2360-9	
Allowable Differences between Contractor and Department Test Results*	
Item	Allowable Difference
Mixture maximum specific gravity (Gmm)	0.019
Adjusted AFT (calculated)	1.2
Fine Aggregate Angularity, uncompacted voids (U) %	1
Coarse Aggregate Angularity, % fractured faces (%P)	15
Aggregate Individual Bulk Specific Gravity (+ No. 4 [+4.75 mm])	0.040
Aggregate Individual Bulk Specific Gravity (- No. 4 [-4.75mm])	0.040
Aggregate combined blend Specific Gravity (Gsb)	0.020
Tensile strength ratio (TSR), %	Table 2360-7
Asphalt binder content:	
Meter method, %	0.2
Spot check method, %	0.2
Chemical extraction methods, %	0.4
Incinerator oven, %	0.3
Chemical vs. meter, spot check, or incinerator methods	0.4
Incinerator oven vs. spot check	0.4
Gradation sieve, % passing:	
1 in [25.0 mm], ¾ in [19.0 mm], ½ in [12.5 mm], ¼ in [9.5 mm]	6
No. 4 [4.75 mm]	5
No. 8 [2.36 mm], No. 16 [1.18 mm], No. 30 [0.60 mm]	4
No. 50 [0.30 mm]	3
No. 100 [0.15 mm]	2
No. 200 [0.075 mm]	1.2
* Test tolerances listed are for single test comparisons.	

G.3 Verification Sample

The Department will test a minimum of one of the companion samples to the Contractor's QC samples and identify this as a verification sample. The Department's verification sample is used to assure compliance of the Contractor's QC program. The verification samples can be any one or all of the splits to the Contractor's QC samples. Additionally, the Department can take a random sample at any time from behind the paver or from the truck box and will consider this a verification sample. The split of this sample, given to the Contractor, must be tested by the Contractor and will replace the next scheduled QC sample. The Department recommends sampling enough material to accommodate retesting in case the samples fail.

The Department will perform verification testing on at least one set of production tests in accordance with 2360.2.G.6.b, "Production," and 2360.2.G.7, "Production Test," on a daily basis per mix type. Use the verification companion sample to verify the requirements of Table 3139-2, Table 3139-3, and Table 2360-7. Compare the verification companion sample to the verification sample for compliance with



allowable tolerances in Table 2360-9, "Allowable Differences between Contractor and Department Test Results." These include the mixture properties of G_{mm} (mixture maximum gravity), G_{mb} (mixture bulk gravity), asphalt binder content, Adjusted AFT (calculated), Coarse and Fine Aggregate crushing, and gradation. Perform one test per week on a verification companion for coarse and fine aggregate crushing meeting the requirements of 2360.2.G.7.g "Coarse Aggregate Angularity" and 2360.2.G.7.h, "Fine Aggregate Angularity." These do not include the aggregate bulk specific gravity G_{sb} , fines to effective asphalt, or the tensile strength ratio (TSR). Determine the asphalt binder content and gradation in accordance with the extraction method specified in 2360.2.G.7.a, "Asphalt Binder Content," or 2360.2.G.7.b, "Gyratory Bulk Specific Gravity."

The Contractor may access the Department's verification test results for G_{mm} (mixture maximum gravity), G_{mb} (mixture bulk gravity), air voids (calculated), asphalt binder content, within 2 working days from the time the sample is delivered to the District Laboratory. The Department will provide the gradation, crushing, and Adj. AFT (calculated) results to the Contractor within three working days. The Department will include the verification test results on the test summary sheet. The Department will compare the results with the Contractor's verification companion for the allowable tolerances in Table 2360-9, "Allowable Differences between Contractor and Department Test Results." The Department will consider the verification process complete if the Contractor's verification companion meets the tolerances in Table 2360-9.

If the tolerances between the Contractor's verification companion and the Department's verification sample do not meet the requirements of Table 2360-9, the Department will retest the material. If the retests fail to meet tolerances, the Department will substitute the Department's verification test results for the Contractor's results in the QC program and use those results for acceptance. The Department will only substitute the out-of-tolerance parameters and will recalculate volumetric properties if applicable.

If the Adj. AFT calculation does not meet the tolerance, equalize the Department Adj. AFT result by increasing the original Department value by 0.5 microns. Use the increased Department Adj. AFT for the Individual Adjusted AFT result and to calculate the Moving Average Adj. AFT results. The increased Department Adj. AFT will form the basis for acceptance.

If the verification sample retests do not meet tolerances, the Department will immediately investigate the cause of the difference that will include a review of testing equipment, procedures, worksheets, gyratory specimen height sheets, and personnel to determine the source of the problem. The Engineer may require both the Department and Contractor to perform at least one hot-cold comparison of mixture properties.

To perform a hot-cold comparison, split the sample into three representative portions. The Engineer will observe the Contractor testing. Immediately compact one part while still hot. Apply additional heating to raise the temperature of the sample to compaction temperature if necessary. Allow the second and third part to cool to air temperature. Retain the second part and transport the third part to the District Materials Laboratory. On the same day and at the same time as the District Materials Laboratory, heat samples to compaction temperature and compact. Develop a calibration factor to compare the specific gravity of the hot compacted samples to reheated compacted samples. Use at least two gyratory specimens for each test. The Engineer or the Contractor may request that this test be repeated.

Reheat mix samples to 160° F [70° C] to allow splitting of the sample into representative fractions for the various tests. Do not overheat the mixture portions used for testing maximum specific gravity test.

The Department will test the previously collected QA samples until they meet the tolerances or until the Department has tested all of the remaining samples. After testing the samples, the Department will test QA samples subsequent to the verification sample until tolerances are met. The Department will base acceptance

on QC data. The Department will base acceptance on QC data with substitution of Department test results for those parameters out of tolerance. Cease mixture production and placement if reestablished test results do not meet tolerances within 48 h. Resume production and placement only after meeting the tolerances. The process for dispute resolution is available on the Bituminous Office website.

If the Engineer analyzes the data using methods for determination of bias on file in the Bituminous Office and finds a bias in the test results, the Engineer will specify which results to use. If through analysis of data, it is determined that there is a bias in the test results, the Engineer will determine which results are appropriate and will govern.

G.4 Contractor Quality Control

G.4.a Personnel

Submit an organizational chart listing the names and phone numbers of individuals and alternates responsible for the following:

- (1) Mix design,
- (2) Process control administration, and
- (3) Inspection.

Provide QC technicians certified as a Level I Bituminous Quality Management (QM) Tester meeting the requirements of the MnDOT Technical Certification Program for QC testing and Level II Bituminous QM Mix Designer to make process adjustments. Provide at least one person per paving operation certified as a Level II Bituminous Street Inspector.

Provide a laboratory with equipment and supplies for Contractor quality control testing and maintain with the following:

- (1) Up-to-date equipment calibrations and a copy of the calibration records with each piece of equipment,
- (2) Telephone,
- (3) Fax and copy machine; however, the Engineer may waive the requirement to have a fax machine if internet and email are available,
- (4) Internet and Email,
- (5) Computer,
- (6) Printer, and
- (7) Microsoft Excel, version 2010 or newer

Laboratory equipment need to meet the requirements listed in Section 400 of the Bituminous Manual, Laboratory Manual, and these specifications, including having extraction capabilities. Before beginning production, the laboratory equipment needs to be calibrated and operational.



Calibrate and correlate all testing equipment in accordance with the Bituminous Manual and Laboratory Manual. Keep records of calibration for each piece of testing equipment in the same facility as the equipment.

G.4.b Sampling and Testing

Take QC samples at random tonnage or locations, quartered from a larger sample of mixture. Sample randomly and in accordance with the Schedule of Materials Control. Determine random numbers and tonnage or locations using the Bituminous Manual; Section 5-693.7 Table A or ASTM D 3665, Section 5, or, an Engineer approved alternate method of random number generation. Sample either behind the paver or from the truck box at the plant site. Other sampling locations can be approved by the Engineer. The Contractor must decide and notify the Engineer where samples will be taken before production begins. The Contractor and Engineer must both agree to a change of sampling location once production has begun. The procedure for truck box sampling is on the Bituminous Office website. The Contractor will obtain at least a 130 pound [60 kg] sample. Split the sample in the presence of the Inspector. The Inspector will retain possession of the Agency portion of each split sample that is taken and randomly submit a minimum of one sample, on a daily basis, to the District Laboratory for Verification testing (see 2360.2.G.3). Store compacted mixture specimens and loose mixture companion samples for 10 calendar days. Label these split companion samples with companion numbers.

If coarse and fine aggregate angularity are not evaluated for every QC sample retain the extracted gradation samples for the respective QC samples for additional testing. Keep the aggregate samples in containers with field identification labels for a period of 10 calendar days. The Engineer will identify which extracted gradation sample is the Verification Companion and whether it is to be tested for coarse and fine aggregate angularity.

G.5 Production Test Requirements

Determine the planned tonnage [metric tons] for each mixture planned for production during the production day. Divide the planned production by 1,000 and round to the next highest whole number. The result is the number of production tests required for the mixture. Table 2360-11, "Production Testing Rates" shows the required production tests.

Split the planned production into even increments and select sample locations as described above. If actual tonnage is greater than the planned tonnage, repeat the calculation above and provide additional tests if the calculation results in a higher number of production tests. During production, the Department will not require mixture volumetric property tests if mix production is no greater than 300 ton [270 tonne]. Provide production tests if the accumulative weight on successive days is greater than 300 ton [270 tonne].

If there is a choice of more than one MnDOT approved test procedure, select one method at the beginning of the project with the approval of the Engineer and use that method for the entire project. The Contractor and Engineer may agree to change test procedures during the construction of the project.

G.5a Establishing an Ignition Oven Correction Factor MnDOT Lab. Manual 1853 Appendix

On the first day of production, for each mixture type, both the Contractor and the Agency will establish an ignition oven correction factor from the produced mixture. Re-establish correction factors when:

There are aggregate or RAP substitutions

There are 3 or more tolerance failures on the extracted asphalt content between the Agency and the Contractor as defined by Table 2360-9, "Allowable Differences between Contractor and Department Test Results".

G.6 Production Testing Rates

G.6.a Start –Up

At the start of production, for the first 2,000 ton [1,800 tonne] of each mix type, perform testing at the following frequencies:



Table 2360-10			
Production Start-Up Testing Rates			
Production Test	Testing Rates	Laboratory Manual Method	Section
Bulk Specific Gravity	1 test per 500 ton [450 tonne]	1806	2360.2.G.7.b
Maximum Specific Gravity	1 test per 500 ton [450 tonne]	1807	2360.2.G.7.c
Air Voids (calculated)	1 test per 500 ton [450 tonne]	1808	2360.2.G.7.d
Asphalt Content	1 test per 500 ton [450 tonne]	1853	2360.2.G.7.a
Add AC/Total AC Ratio (calculated)	1 test per 1000 ton [900 tonne]	1853	2360.2.G.7.a
Adj. AFT (Calculated)	1 test per 500 ton [450 tonne]	1854	2360.2.E.6.b
Gradation	1 test per 500 ton [450 tonne]	1203	2360.2.G.7.f
Coarse Aggregate Angularity	1 test per 1,000 tons [900 tonne]	1214	2360.2.G.7.g
Fine Aggregate Angularity (FAA)	1 test per 1,000 ton [900 tonne]	1206	2360.2.G.7.h
Fines to Effective Asphalt Ratio (calculated)	1 test per 500 ton [450 tonne]	1203 & 1853	2360.2.G.7.f & 2360.2.G.7.a

G.6.b Production

After producing the first 2,000 ton [1,800 tonne] of each mix type test at the following frequencies:

Table 2360-11 Production Testing Rates			
Production Test	Sampling and Testing Rates	Test Reference	Section
Bulk Specific Gravity	Divide the planned production by 1,000. Round the number to the next higher whole number	Laboratory Manual 1806	2360.2.G.7.b
Maximum Specific Gravity	Divide the planned production by 1,000. Round the number to the next higher whole number.	Laboratory Manual 1807	2360.2.G.7.c
Air Voids (calculated)	Divide the planned production by 1,000. Round the number to the next higher whole number	Laboratory Manual 1808	2360.2.G.7.d
Asphalt Content	Divide the planned production by 1,000. Round the number to the next higher whole number	Laboratory Manual 1853	2360.2.G.7.a
Add AC/Total AC Ratio (calculated)	Divide the planned production by 1,000. Round the number to the next higher whole number	Laboratory Manual 1853	2360.2.G.7.a
Adj. AFT (Calculated)	Divide the planned production by 1,000. Round the number to the next higher whole number	Laboratory Manual 1854	2360.2.E.7.e
Gradation	1 gradation per 1,000 tons [900 tonne], or portion thereof (at least one per day)	Laboratory Manual 1203	2360.2.G.7.f
Coarse Aggregate Angularity	2 tests per day for at least 2 days, then 1 per day if CAA is met. If CAA >8% of requirement, 1 sample per day but test 1 per week.	Laboratory Manual 1214	2360.2.G.7.g
Fine Aggregate Angularity (FAA)	2 tests per day for at least 2 days, then 1 per day if FAA is met. If FAA >5% of requirement, 1 sample per day but test 1 per week.	Laboratory Manual 1206	2360.2.G.7.h
Fines to Effective Asphalt Ratio (calculated)	Divide the planned production by 1,000. Round the number to the next higher whole number	Laboratory Manual 1203 & 1853	2360.2.G.7.f & 2360.2.G.7.a
TSR	As directed by the Engineer	Laboratory Manual 1813	2360.G.7.i
Aggregate Specific Gravity	As directed by the Engineer	Laboratory Manual 1204, 1205, and 1815	2360.G.7.j
Mixture Moisture Content	Daily unless otherwise required by the Engineer	Laboratory Manual 1855	2360.G.7.k



Table 2360-11			
Production Testing Rates			
Production Test	Sampling and Testing Rates	Test Reference	Section
Asphalt Binder	Sample first load (each grade), then 1 per 250,000 gal sample size 1 qt [1,000,000 L]	MnDOT Bituminous Manual 5-693.920	2360.G.7.1

G.7 Production Tests

G.7.a Asphalt Binder Content

Spotchecks are required only when the Engineer has waived the requirements of 2360.2G8 relating to furnishing a computerized printout of the plant blending control system. A minimum of 1 spotcheck per day per mixture blend is required to determine the new added asphalt binder.

Use an incinerator oven meeting the requirements of the Laboratory Manual Method 1853. Do not use the incinerator oven if the percentage of Class B material is greater than 50 percent within the composite blend, unless the Contractor determines a correction factor approved by the Engineer.

Perform chemical extraction meeting the requirements of Laboratory Manual Method 1851 or 1852.

G.7.b Gyratory Bulk Specific Gravity, Gmb

Use two specimens to determine gyratory bulk specific gravity meeting the requirements of Laboratory Manual Method 1806. Set Gyratory to an internal angle of $1.16^\circ \pm 0.02^\circ$ according to AASHTO TP 71.

G.7.c Maximum Specific Gravity, Gmm

Determine maximum specific gravity meeting the requirements of Laboratory Manual Method 1807.

G.7.d Air Voids – Individual and Isolated (Calculation)

Calculate the individual and isolated air voids meeting the requirements of Laboratory Manual Method 1808. Use the maximum mixture specific gravity and corresponding bulk specific gravity from a single test to calculate the isolated air voids. Use the maximum specific gravity moving average and the bulk specific gravity from a single test to calculate the individual air voids.

Compact gyratory design to N_{design} in accordance with Table 2360-7, “Mixture Requirements” for the specified traffic level.

G.7.e Adjusted Asphalt Film Thickness (AFT) (Calculation)

Calculate the Adj. AFT meeting the requirements of the Laboratory Manual Method 1854.

G.7.f Gradation – Blended Aggregate

Determine the gradation of blended aggregate sample, from an extracted bituminous mixture, meeting the requirements of Laboratory Manual Method 1203.

G.7.g Coarse Aggregate Angularity

Test the Coarse Aggregate Angularity (CAA) meeting the requirements of Laboratory Manual Method 1214 to determine the CAA on composite blend from aggregates used in production of hot mix asphalt. Ensure CAA test results meet the requirements in accordance with Table 3139-3.

The Contractor may test mixtures containing virgin aggregates from composite belt samples. Test mixtures containing RAP from extracted aggregates taken from standard production samples. Test the percentage of fractured faces of the composite aggregate blend less than 100 percent twice a day for each mixture blend for at least two days, then one test per day if the test samples meet the CAA requirements. If the CAA crushing test results are greater than 8 percent of the requirements, take one sample per day and perform one test per week.

Report CAA results on the test summary sheet. The Department may reduce payment in accordance with Table 2360-15, "Reduced Payment Schedule for Individual Test Results," for mixture placed and represented by results below the minimum requirement in accordance with Table 3139-3. The Department will calculate tonnage subjected to reduced payment as the tons placed from the sample point of the failing test to the sampling point where the test result meets the specifications.

G.7.h Fine Aggregate Angularity

Use Laboratory Manual Method 1206 to test the composite blend from aggregates used in production of asphalt mixtures for Fine Aggregate Angularity (FAA) meeting the requirements of Table 3139-3. The Contractor may test mixtures that contain virgin aggregates from composite belt samples. Test mixtures that contain RAP from extracted aggregates taken from standard production samples. Perform two tests per day for each mixture blend for at least two days to test the percentage of uncompacted voids from the composite aggregate blend, then one test per day if the samples meet FAA requirements. If FAA test results are greater than 5 percent of the requirement, take one sample per day and one test per week.

Report FAA results on the test summary sheet. The Department may reduce payment in accordance with Table 2360-16, "Reduced Payment Schedule for Individual Test Results," for mixture placed and represented by results below the minimums in accordance with Table 3139-3. The Department will calculate tonnage subjected to reduced payment as the tons placed from the sample point of the failing test to the sampling point where the test result meets the specifications.



G.7.i..... Field Tensile Strength Ratio (TSR)
..... Laboratory Manual Method 1813

If the Engineer requires sampling and testing of the mixture to verify tensile strength ratio (TSR), both the Contractor and the Department will be required to test these samples within 72 h after sampling. The Contractor shall obtain a sample weighing at least 110 lb [50 kg] and split the sample in half to provide a sample for the Department and the Contractor. Label the Department companion of this split with the following information:

- (1) Date,
- (2) Time,
- (3) Project number, and
- (4) Cumulative tonnage to date.

After the sample is split and labeled, give the Department's companion sample to the Department Street Inspector or Plant Monitor or to the Materials Engineer within 24 h of sampling as directed by the Engineer. When using Option 2, obtain the sample within the first 5,000 ton [4,500 tonne] of plant mixed asphalt produced or by the second day of production, whichever comes first, to verify tensile strength ratio (TSR). Take mixture samples from the windrow or truck box. Provide a 6 in [150 mm] specimen for gyratory design. The Contractor may test the sample at a permanent lab site or a field lab site.

Refer to Table 2360-12, "Mixture Type, Minimum TSR," for the minimum acceptable TSR values for production. Stop production immediately if the material does not meet minimum TSR requirements. Do not resume production until after adding anti-strip to the asphalt binder. Determine the responsible party for the cost of the anti-strip in accordance with the Department and Contractor TSR values in Table 2360-13. If the Department is responsible for the cost of the anti-strip, the Department will only pay for the cost of the anti-strip for mixtures placed on that project. The Department will not pay for delay costs associated with making changes related to this testing.

Table 2360-12			
Mixture Type, Minimum TSR			
Traffic Level 2 – 3, %		Traffic Level 4 – 5, %	
Contractor	MnDOT	Contractor	MnDOT
75	65	80	70

Table 2360-13			
Anti-Strip Cost Responsibility			
Gyratory Level	Contractor TSR	MnDOT TSR	Responsibility
2 – 3	≥ 75	≥ 65	No anti-strip required
		< 65	Contractor
	< 75	≥ 65	Department
		< 65	Contractor
4 – 5	≥ 80	≥ 70	No anti-strip required
		< 70	Contractor
	< 80	≥ 70	Department
		< 70	Contractor

Take another sample and test within the first 500 ton [450 tonne] after production resumes. Stop production if the re-test fails to meet the minimum specified value. Discuss a proposal to resolve the problem with the Engineer before resuming production. Do not operate below the specified minimum TSR if at least 2 successive tests fail the TSR requirements.

A new sample and retest is automatically required if a proportion changes by greater than 10 percent from the currently produced mixture for a single stockpile aggregate or the Engineer directs the Contractor to sample and retest.

G.7.j.....Aggregate Specific Gravity(Gsb)
.....Laboratory Manual Methods 1204, 1205, 1815

Sample and test aggregate stockpiles to verify aggregate specific gravity if directed by the Engineer in conjunction with the District Materials Engineer. Provide 90 lb [40 kg] representative stockpile samples for each aggregate component. Split samples in half to provide material for both the Department and the Contractor. Label the Department companion with the following information:

- (1) Date,
- (2) Time,
- (3) Project number, and
- (4) Approximate cumulative tonnage to date.

Give the Department companion to the Department Street Inspector or Plant Monitor immediately after splitting or to the Materials Engineer within 24 h of sampling as directed by the Engineer. The Materials Engineer will compare the aggregate specific gravity results to the Contractor's values on the current Mix Design Report. If the results deviate beyond the tolerance in accordance with Table 2360-16, "Allowable Differences between Contractor and Department Test Results," the Materials Engineer will notify the Contractor and issue a new Mix Design Report with the current specific gravity results. Base new mixture placed after receiving notification of new specific gravity values on the Department results. The Engineer will notify the Contractor regarding new specific gravity values. The dispute resolution procedure for aggregate specific gravity is on the Bituminous Office website.



G.7.k..... Moisture Content
..... Laboratory Manual Method 1855

Provide a mixture with moisture content no greater than 0.3 percent. Measure moisture content in the mixture behind the paver or, if approved by the Engineer, in the truck box. Sample and test as directed by the Engineer. Store the sample in an airtight container. Do not perform microwave testing.

Do not provide plant mixed asphalt with a moisture content greater than 0.3 percent.

G.7.1 Asphalt Binder Samples

Obtain asphalt binder samples from a sampling valve located between the pump and the drum. Sample each type of asphalt binder used in mixture production after 50 tons of mixture has been produced, then sample at a rate of one per 250,000 gal [1,000,000 L. A minimum of 1 gallon of binder must be drawn and wasted from the sampling valve before the actual sample is drawn. For batch plants, obtain the asphalt binder sample from the weigh pod. Provide a 1 qt [1.0 L] sized sample. The Inspector will monitor the sampling the Contractor performs. Record sample information on an Asphalt Sample Identification Card. Submit the sample to the Central Materials Laboratory. Contact the Department Chemical Laboratory Director for disposition of failing asphalt binder samples.

G.8 Documentation

Maintain documentation, including test summary sheets and control charts, on an ongoing basis. Maintain a file of gyratory specimen heights for gyratory compacted samples and test worksheets. File reports, records, and diaries developed during the work as directed by the Engineer. These documents become the property of the Department.

Number test results in accordance with the MDR and record on forms approved and provided by the Department.

Send production test results on test summary sheets to the District Materials Laboratory and to other sites as directed by the Engineer by 11 AM of the day following production by facsimile, or e-mail when approved by the Engineer.

Include the following production test results and mixture information on the Department approved test summary sheet:

- (1) Percent passing on all sieves in accordance with Table 3139-2 (including No. 16, No. 30, No. 50, No. 100),
- (2) Coarse and fine aggregate crushing,
- (3) Maximum specific gravity (G_{mm}),
- (4) Bulk specific gravity (G_{mb}),
- (5) Percent total asphalt binder content (P_b),
- (6) New added asphalt binder content,

- (7) Ratio of % new added asphalt binder to total asphalt binder,
- (8) Calculated production air voids (V_a),
- (9) Calculated adjusted AFT (Adj. AFT),
- (10) Composite aggregate specific gravity (G_{sb}) reflecting current proportions,
- (11) Aggregate proportions in use at the time of sampling,
- (12) Tons where sampled,
- (13) Tons represented by a test and cumulative tons produced,
- (14) Fines to effective asphalt ratio (F/A_e),
- (15) Signature Line for MnDOT and Contractor Representative,
- (16) Mixture Moisture Content, and
- (17) MnDOT verification sample test result.
- (18) Identify, when used, the WMA additive or process and dosing rates.

Submit copies of failing test results to the Engineer on a daily basis.

Provide the Engineer with asphalt manifests or bill of lading's (BOL) on a daily basis.

Provide a daily plant diary, including a description of QC actions taken. Include changes or adjustments on the test summary sheets.

Provide weekly truck scale spot checks.

Provide a Department approved accounting system for mixes and provide a daily and final project summary of material quantities and types.

Provide a final hard and electronic copy of QC test summary sheets and control charts, and density worksheets at completion of bituminous operations on the project to the Engineer.

Provide an automated weigh scale and computer generated weigh ticket. Ensure the ticket indicates the following information:

- (1) Project number,
- (2) Mix designation, including binder grade,
- (3) Mixture Design Report number,
- (4) Truck identification and tare,
- (5) Net mass, and
- (6) Date and time of loading.

Do not include deviations from the minimum information on the computer generated weigh ticket unless otherwise approved by the Engineer in writing.



Continue test summary sheets, charts, and records for a mixture produced at one plant site from contract to contract. Begin new summary sheets and charts annually for winter carry-over projects. Begin new summary sheets and charts when an asphalt plant is re-setup in the same location after it has moved out.

Furnish an electronic printout (long form recordation) from an automated plant blending control system at 20 minute intervals when the plant is producing mixture. The Engineer may waive this requirement if the plant does not have the capability to produce the automated blending control information; however, the Contractor must then perform daily spotchecks to determine percent new asphalt added.

Include the following information on the plant control printout for Drum Plants:

- (1) Both the virgin and recycle belt feed rates (tons/hr),
- (2) Feeder bin proportions (%),
- (3) Total % asphalt cement in the mixture,
- (4) Virgin asphalt cement added (%)
- (5) Mixture Temperature °F [°C],
- (6) Mixture code,
- (7) Date and time stamp, and
- (8) Current tons of mixture produced and daily cumulative tons of mixture produced at time of printout.

Provide a daily electronic printout of the plant calibration (SPAN) numbers for each bin and meter.

Include the following information on the plant control printout for Batch Plants:

- (1) Both the virgin and recycle belt feed rates (tons/hr),
- (2) Feeder bin proportions (%),
- (3) Mixture Temperature °F [°C],
- (4) Mixture code,
- (5) Date and time stamp, and
- (6) Current tons of mixture produced and daily cumulative tons of mixture produced at time of printout.

Provide a daily electronic printout of the plant calibration (SPAN) numbers for each bin and meter.

G.9 Control Charts

Provide control charts and summary sheets computer generated from software approved by the Engineer. The Contractor may use software available at the Bituminous Office. Record the following data on standardized control charts:

- (1) Blended aggregate gradation, include sieves in accordance with Table 3139-2 for specified mixture;
- (2) Percent asphalt binder content (P_b);
- (3) Maximum specific gravity (G_{mm});
- (4) Production air voids (V_a); and
- (5) Adj. AFT.

Unless otherwise directed by the Engineer, plot individual test results for each test point and connect individual points with a solid line. Plot the moving average for each test variable starting with the fourth test and connect with a dashed line. Plot the Department's QA and verification test results with triangles. Plot the specification JMF limits on the control charts using a dotted line.

G.10 JMF Limits

Base the production air voids and Adj. AFT on the minimum specified requirements in accordance with Table 2360-7, "Mixture Requirements." Base gradations and asphalt binder content limits on the current Department reviewed Mixture Design Report. Provide gradation control sieves in accordance with Table 3139-2. Refer to the Mixture Design Report for the mixture production targets. JMF limits are the target plus or minus the limits in accordance with Table 2360-14, "JMF Limits (N=4)." Use JMF limits as the criteria for acceptance of materials based on the moving average.

Table 2360-14 JMF Limits (N=4)	
Item	JMF Limits
Adj. AFT	- 0.5
Production air voids, %	± 1.0
Asphalt binder content, %	- 0.4
Sieve, % <i>passing</i> :	
1 in [25.0 mm], $\frac{3}{4}$ in [19.0 mm], $\frac{1}{2}$ in [12.5 mm], $\frac{3}{8}$ in [9.5 mm], No. 4 [4.75 mm]	Broad band limits
No. 8 [2.36 mm]	Broad band limits
No. 200 [0.075 mm]	Broad band limits

G.11 Moving Average Calculation

Calculate a moving average as the average of the last four test results. Continue the calculation without interruption, except begin new summary sheets and charts annually for winter carry-over projects and if an asphalt plant is re-setup in the same site after it has been moved out.

G.12 JMF Bands



JMF Bands are the area between the target, as identified on the Mixture Design Report, and the JMF limits.

G.13 JMF Adjustment

Begin mixture production with aggregate proportions within 5 percent of the design proportions and mixture parameters in Table 2360-14 within the JMF limits shown. Use all the aggregate proportions included on the Mixture Design Report unless the aggregate proportion is shown as 0 percent. If the Contractor provides the District Materials Laboratory with prior documented production data showing how production affects the mixture properties or if the Contractor provides the District Materials Laboratory with a written justification or explanation of material changes since the original mixture submittal waive the preceding requirements.

G.13.a JMF Request for Adjustment

The Contractor may make a request to the Bituminous Engineer or District Materials Engineer for a JMF adjustment to the mix design if the QC test results indicate a necessary change to achieve the specified properties. Do not use aggregates or materials not part of the original mix design to make adjustments unless otherwise approved by the Engineer, in conjunction with the District Materials Engineer or the Department Bituminous Engineer.

A Certified Level II Bituminous QM Mix Designer will review the requested change for the Department. If the request meets the design requirements in Table 3139-2, "Aggregate Gradation Broad Bands", Table 3139-3, "Mixture Aggregate Requirements", and Table 2360-7, "Mixture Requirements," the Department will issue a revised Mixture Design Report. Each trial mixture design submittal in accordance with 2360.2.E, "Mixture Design" may have three JMF adjustments per mixture per project without charge. The Department will charge the Contractor \$500 for each additional JMF adjustment requests.

Perform an interactive process with the Engineer before making JMF adjustments. Make JMF adjustments only within the mixture specification gradation design broadbands in accordance with Table 3139-2. Submit a new JMF if redesigning the mixture. Only reduce the JMF asphalt content if the moving average Adj. AFT is 8.5 μ or more and Individual Adjusted AFT is at least 7.5 μ .

The department will not allow consecutive requests for a JMF adjustment without production data. Continue calculation of the moving average after the approval of the JMF.

G.13.b JMF Request for Adjustment for Proportion Change > 10%

If requesting a JMF adjustment for a proportion change greater than 10 percent from the currently produced mixture for a single stockpile aggregate, provide supporting production test data from at least four tests run at an accelerated testing rate of one test per 500 ton [450 tonne] with the adjustment request. The Department will base acceptable verification and approval of the requested JMF on individual and moving average test results in addition to the requirements listed above. Individual test results must be within twice the requested JMF limits for percent asphalt binder, production air voids, and Adj. AFT. Individual gradations must be within the Broad Bands. The moving average values must be within the control limits in accordance with Table 2360-14. Continue to calculate the moving average after the change in proportions.

If the mixture meets the design requirements as discussed in G.13.a, the District Materials Laboratory will sign the request for JMF adjustment effective from the point of the proportion change. If the mixture fails to meet the design requirements, the Department will either reduce the payment or direct the Contractor to remove and replace. Do not make consecutive requests for JMF adjustments without production data.

G.13.c JMF Request for Adjustment When Cumulative Proportion Changes > 10%

Submit a request for JMF adjustment when the cumulative change on any one product exceeds 10% from the original MDR. The Department will issue a revised MDR provided the mixture meets the requirements in Table 3139-2, "Aggregate Gradation Broad Bands", Table 3139-3, "Mixture Aggregate Requirements", and Table 2360-7, "Mixture Requirements".

G.14 Failing Materials

The Department will base material acceptance on individual and moving average test results. The Department will use isolated test results for acceptance of air voids at the start of mixture production. The Department will consider individual test results greater than two times the JMF bands as failing. The Department will fail moving average test results exceeding the JMF limits. Begin new summary sheets annually for winter carry-over projects.

Stop production and make adjustments if the moving average values exceed the JMF limits. Restart production after performing the adjustments and notifying the Engineer. Resume testing at the accelerated rates and for the tests listed in Table 2360-10, "Production Start-Up Testing Rates," for the next 2,000 ton [1,800 tonne] of mixture produced. Continue calculating the moving average after the stop in production.

The Department will consider mixture produced where the moving average of four exceeds the JMF limits as unsatisfactory in accordance with 2360.2.G.14.d, "Moving Average Failure at Mixture Start-Up — Production Air Voids," 2360.2.G.14.e, "Moving Average Failure at Mixture Start-Up — Adjusted AFT," 2360.2.G.14.f, "Moving Average Failure - Production Air Voids," and 2360.2.G.14.g, "Moving Average Failure — Percent Asphalt Binder Content, Gradation, and Adj. AFT."

If the total production of a mixture type for the entire project requires no greater than four tests the Department will accept the material in accordance with 2360.2.G.14.b, "Isolated Failures at Mixture Start-Up — Production Air Voids," and 2360.2.G.14.c, "Individual Failure — Gradation, Percent Asphalt Binder, Production Air Voids, and Adj. AFT."

If the Contractor's testing data fails to meet the tolerances in accordance with Table 2360-9, "Allowable Differences between Contractor and Department Test Results," the Department will substitute QA and verification data to determine the payment factor.

G.14.a Ratio of New Added Asphalt Binder to Total Asphalt Binder — Acceptance Criteria

Minimum design ratio of new added asphalt binder to total asphalt binder is shown in Table 2360-15 below. During production the ratio must meet individual and moving average requirements as listed in



Table 2360-15, "Ratio of New Added Asphalt Binder to Total Asphalt Binder Acceptance Criteria". If the individual or moving average ratio drops below the minimum requirement, the Contractor must stop production and make adjustments to correct the process. Restart production only after notifying the Engineer of the adjustments made. The calculation of the moving average will continue after the stop in production.

Table 2360-15			
Ratio of New Added Asphalt Binder to Total Asphalt Binder Acceptance Criteria			
Specified Asphalt Grade	Recycled Material		
	RAS Only	RAS + RAP	RAP Only
PG XX-28, PG 52-34, PG 49-34, PG 64-22			
Wear (ind./moving average)	66/70	66/70	66/70
Non-Wear (ind./moving average)	66/70	66/70	61/65
PG 58-34, PG 64-34, PG 70-34			
Wear & Non-Wear (ind./moving average)	76/80	76/80	76/80

G.14.b Isolated Failures at Mixture Start-Up – Production Air Voids

At the start-up of mixture production, use the first three isolated test results for production air voids before establishing a moving average of four. Calculate isolated production air voids using the maximum mixture specific gravity and the corresponding bulk specific gravity from that single test. After testing four samples and establishing a moving average of four, the Department will base acceptance on individual and moving average production air voids.

The Department will not accept the material if any of the first three isolated test results for production air voids exceeds twice the JMF bands from the target listed on the Mixture Design Report at the start of production. The Department will reduce payment for unacceptable material in accordance with Table 2360-16, "Reduced Payment Schedule for Individual Test Results." The Department will calculate the quantity of unacceptable material on the tonnage placed from the sample point of the failing test to the sample point when the isolated test result is back within twice the JMF bands. If the failure occurs at the first test after the start of production, the Department will calculate the tonnage subject to reduced payment as described above, including the tonnage from the start of production.

If isolated air voids are less than 1.0 percent or greater than 7.0 percent, the Engineer will either reduce the payment or order the material removed and replaced at no additional cost to the Department. The Engineer may require the Contractor to test in-place mixture to better define the removal and replacement limits. The Engineer may require the Contractor to test in-place mixture placed before the failing test result. If the Engineer reduces the payment, the Department will pay for the material at 50 percent of the contract unit price.

G.14.c Individual Failure – Percent Asphalt Binder, Production Air Voids, and Adj. AFT

Table 2360-16	
Reduced Payment Schedule for Individual Test Results	
Item	Pay Factor, % *

Table 2360-16	
Reduced Payment Schedule for Individual Test Results	
Item	Pay Factor, % *
Coarse and fine aggregate crushing	90
Asphalt binder content	90
Production air voids, individual and isolated†	80
<p>* Apply the lowest pay factor when using multiple reductions on a single test.</p> <p> Calculate individual air voids using the moving average maximum specific gravity and the bulk specific gravity from that single test.</p> <p>† Calculate the isolated air voids from the maximum specific gravity and the bulk specific gravity from that single test. The Engineer will only use isolated void test results for acceptance for the first three tests after mixture production start-up.</p>	

If the individual test result for adjusted AFT is less than 7.5 μ , the Department may either reduce payment in accordance with Table 2360-17, "Reduced Payment Schedule for Individual Test Results, Adjusted AFT," or order the material removed and replaced represented by the individual test. This tonnage includes all material placed from the sample point of the failing test to the sample point when the test result meets specification requirements. If the failure occurs at the first test after the start of daily production, the Department will include the tonnage from the start of production that day with the tonnage subject to reduced payment or removal and replacement.

Table 2360-17	
Reduced Payment Schedule for Individual Test Results, Adjusted AFT	
Individual Adjusted AFT, μ	Pay Factor, %
≥ 7.5	100
7.4 – 7.0	90
6.9 – 6.1	75
≤ 6.0	R&R ^(*)
* Remove and replace at no expense to the Department.	

The Department will not accept material if the individual tests for percent asphalt binder content or production air voids exceeds twice the JMF bands from the target listed on the Mix Design Report. The Department will reduce payment in accordance with Table 2360-16, "Reduced Payment Schedule for Individual Test Results." The Department will calculate the material subject to reduced payment as the material placed from the sample point of the failing test until the sample point when the test result is back within twice the JMF limits. If the failure occurs at the first test after the start of daily production, the Department will include tonnage from the start of production that day with the tonnage subjected to reduced payment.

The Department will not accept material if individual air voids are less than 1.0 percent or greater than 7.0 percent. Remove and replace unacceptable material at no additional cost to the Department as directed by the Engineer. Test in-place mixture to better define the area to be removed and replaced as directed by the Engineer. Test mixture placed before the failing test result as directed by the Engineer. The Department may reduce payment for unacceptable material at 50 percent of the relevant contract unit price.



G.14.d Moving Average Failure at Mixture Start-Up — Production Air Voids

If a moving average failure occurs within any of the first three moving average results after mixture start-up (tests 4, 5, 6), the Department will accept the mixture if the individual air void, corresponding to the moving average failure meets the JMF limits. The Department will not accept material if the individual air void fails to meet the JMF limit. The Department will reduce payment for unacceptable material unless the Engineer determines that the isolated air void corresponding to the individual air void meets the JMF limit. The Department will pay for unacceptable material at 70 percent of the relevant contract unit price. The Department will calculate the quantity of material subject to reduce payment as the tons placed from the sample point of the failing moving average result and corresponding individual air void beyond the JMF limit to the sampling point when the individual test result is back within the JMF limit. If the failure occurs at the first test after the start of daily production, the Department will include tonnage from the start of production that day with the tonnage subjected to reduced payment.

G.14.e Moving Average Failure at Mixture Start-Up — Adj. AFT

The Engineer will calculate the Moving Average (n=4) Adj. AFT during the sixth test after the beginning of mixture production of that specific mixture. The Engineer will include the individual results of calculations for tests No. 3, No. 4, No. 5, and No. 6 with this calculation.

G.14.f Moving Average Failure — Production Air Voids

A moving average production air void failure occurs when the individual production air void moving average of four exceeds the JMF limit. The Department will consider the mixture unacceptable and subject to reduced payment. The Department will pay for unacceptable mixture at 70 percent of the contract unit price. The Department will calculate the quantity of mixture subject to reduced payment as the tons placed from the sample point of all individual test results beyond the JMF limits, which contributed to the moving average value that exceeded the JMF limit, to the sampling point where the individual test result meets the JMF limits. If the failure occurs at the first test after the start of daily production, the Department will include the tonnage from the start of production that day with the tonnage subject to reduced payment.

Table 2360-18	
Reduced Payment Schedule for Moving Average Test Results	
Item	Pay Factor, % *
Gradation	90
Coarse and fine aggregate crushing	NA (individual failures only)
Adjusted AFT	80
Asphalt binder content	80
Production air voids	70
* Lowest Pay Factor applies when there are multiple reductions on a single test.	

G.14.g Moving Average Failure - Percent Asphalt Binder Content, Gradation, and Adj. AFT

The Engineer will consider the mixture unacceptable and subject to reduced payment for mixture properties, including asphalt binder content and gradation, where the moving average of four exceeds the JMF limits. The Department may reduce payment for unacceptable mixture properties in accordance with Table 2360-18, "Reduced Payment Schedule for Moving Average Test Results." The Department will calculate the quantity of material subject to replacement or reduced payment as the tons placed from the sample point of all individual test results beyond the JMF limits, which contributed to the moving average value that exceeded the JMF limit, to the sampling point when the individual test result is back within the JMF limits. If the failure occurs at the first test after the start of daily production, the Department will include the tonnage from the start of production that day with the tonnage subjected to reduced payment.

The Engineer will calculate the Moving Average (n=4) Adjusted AFT during the sixth test after the beginning of mixture production of that specific mixture. The Engineer will include the individual results of calculations for tests No. 3, No. 4, No. 5, and No. 6 with this calculation. The Department will consider material with the Moving Average (n=4) of the Adjusted AFT is less than 8.0 μ as unsatisfactory and will pay for the material at 80 percent of the relevant contract unit price. The Department will calculate the quantity of material subject to replacement or reduced payment as the tons placed from the sample point of all Individual Adjusted AFT results less than 8.0 μ , which contributed to the Moving Average value that was less than 8.0 μ , to the sample point where the Individual Adjusted AFT is at least 8.0 μ . If the failure occurs at the first test after the start of daily production, the Department will include the tonnage from the start of production that day with the tonnage subject to reduced payment.

G.14.h Coarse and Fine Aggregate Crushing Failure

If any CAA or FAA test results do not meet the requirements specified in Table 3139-3, the Department may reduce payment for the placed material in accordance with Table 2360-16, "Reduced Payment Schedule for Individual Test Results." The Department will calculate the quantity of material subject to reduced payment as the tons placed from the sample point of the failing test until the sampling point where the test result meets the specifications. If the failure occurs at the first test after the start of daily production, the Department will include the tonnage from the start of production that day with the tonnage subjected to reduced payment.

2360.3 CONSTRUCTION REQUIREMENTS

A Restrictions

A.1 Asphalt Release Agents

Do not use petroleum distillates to prevent adhesion of asphalt mixtures to equipment. An asphalt release agent must meet the criteria for "Effect on Asphalt" as described in the most recent Asphalt Release Agent on file in MnDOT's Office of Environmental Services.

A.2 Edge Drop Off

When construction is under traffic, the requirements of 2221.3.D will apply.

A.3 Surge and Storage Bins



Store the asphalt mixture for no more than 18 h at storage facilities that prevent segregation of the mix and drainage of asphalt from the mix. Maintain the mixture at within 9 °F [5 °C] of the temperature when discharged from the silo or mixer and prevent excessive cooling or overheating.

A.4 Weather Limitations and Paving Date

Do not perform work within the roadway in the spring until removal of seasonal load restrictions on roads in the vicinity unless otherwise approved by the Engineer.

Do not place asphalt mixtures when weather or roadbed conditions or moisture conditions of the roadway surface are judged unfavorable by the Engineer.

Do not place asphalt pavement final wearing course lift after October 15 north of an east-west line between Browns Valley and Holyoke, or after November 1 south of an east-west line between Browns Valley and Holyoke. The Engineer may waive these restrictions when:

- (1) The Contractor is not placing asphalt mixture on the traveled portion of the roadway,
- (2) The roadway involved is closed to traffic during the following winter, or
- (3) The Engineer provides written direction to place the mixture.

A.5 Mixing and Discharge of Materials

Notify the Engineer of the recommended plant mixing temperatures as provided from the asphalt supplier. Unless authorized by the Engineer, do not produce the mixture more than 30°F above the recommended maximum mixing temperature. Use the automated plant control printout to monitor discharge temperature. The Department will not pay for or allow placement of any mixture produced at more than 30°F above the recommended maximum mixing temperature unless the higher mixing temperatures have been approved by the Engineer.

B Equipment

B.1 Plant

B.1.a Segregation

Provide plant mixed asphalt from a plant capable of producing a uniform mix free of segregation.

B.1.b Scales

Test and calibrate scales in accordance with 1901.

B.1.c Mineral Filler

Add mineral filler to the mixture using a storage silo equipped with a device to ensure a constant and uniform feed.

B.1.d Storage Tanks

Provide storage tanks equipped to heat and maintain the material at the temperatures recommended by the certified asphalt supplier. Place the discharge end of the circulating line below the surface of the asphalt material. Provide agitation for modified asphalt as recommended by the supplier.

Provide an outage table or chart and measuring stick for each storage or working tank. Equip tanks with provisions to take asphalt binder material samples. After delivery of asphalt binder material to the project, do not heat the material at temperatures greater than 350° F [175° C]. Do not store modified asphalt at temperatures greater than the manufacturer's recommendation.

B.1.e Asphalt Binder Control

If proportioning asphalt binder material by volume, equip the plant with either a working tank or a metering system to determine asphalt binder content of the mixture.

Provide a working tank with a capacity from 1,000 gal to 2,000 gal [3,800 L to 7,600 L]. Calibrate and supply the working tank with a calibrated measuring stick. The Contractor may connect the tank to a mixing unit and use it only during spot check operations as long as it is available at all times. Return feedback to the working tank during spot check operations.

Provide a metering system with at least one approved asphalt binder flow meter and a asphalt binder pump. Connect the flow meter to the asphalt binder supply to measure and display only the asphalt binder being fed to the mixer unit. Position the meter readout for convenient observation. Provide a means to compare the flow meter readout with the calculated output of the asphalt binder pump. Provide a system to display that shows the accumulated asphalt binder quantity being delivered to the mixer in gallons [liters] or to the nearest 0.001 ton [0.001 tonne]. Calibrate and adjust the system to maintain an accuracy of ± 1 percent error for each plant set-up before producing the mixture.

Provide an outage table or chart and measuring stick for each storage or working tank. Equip tanks with provisions to take asphalt binder material samples. After delivery of asphalt binder material to the project, do not heat the material at temperatures greater than 350° F [175° C]. Do not store modified asphalt at temperatures greater than the manufacturer's recommendation.

B.1.e (1) Asphalt Binder Sampling Valve

Provide an asphalt binder sampling valve located between the pump and the drum. Sample asphalt binder from the weigh pod for batch plants.

B.1.f Dryer



The Department will not allow unburned fuel in the mix.

B.1.g Temperature Control

Equip the plant with enough temperature sensors to ensure temperature control of the aggregate and asphalt binder.

B.1.h **Pollution**
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B.2 Street Equipment

B.2.a Paver

Provide a paver capable of spreading and finishing to widths as shown on the plans and with an operational vibratory screed and automatic screed control to place mix without segregation.

Use an asphalt paver to place the mixture. When necessary, the Contractor may use a motor grader, when approved by the Engineer, to spread mixtures in areas that are inaccessible to a paver or when the quantity of mixture makes it impractical to place with a paver.

Use a shouldering machine to spread the mixture on shoulder surfacing and uniform width widening, when the placement width is too narrow for a paver.

Using a screed or strike-off assembly, produce a finished surface of the required evenness and texture without tearing, shoving, or gouging. For mainline paving, if the paving width is greater than the basic screed, auger and mainframe extensions, which meet manufacturer's recommendations for the paving width, are required unless otherwise directed by the Engineer. The Department will not allow strike-off only extension assemblies for mainline wearing course paving, unless the Engineer directs otherwise.

Equip all pavers with an approved automatic screed control. Sensor-operated devices need to include automatic controls that follow reference lines, or surfaces on one or both sides of the paver as required. Adjust the speed of the paver to produce the best results. A string line is only required if stated in the contract.

Spread all mixtures without segregation to the cross sections shown on the plans (excluding tight blade and scratch course applications). The objective on the leveling layer is to secure a smooth base of uniform grade and cross section so that subsequent courses will be uniform in thickness. The Contractor may spread the leveling layer with a properly equipped paver or, when approved by the Engineer, a motor grader equipped with a leveling device or with other means for controlling the surface elevation of the leveling layer.

Place each course over the full width of the section under construction on each day's run, unless the Engineer directs otherwise.

B.2.b Trucks

Provide trucks with tight, clean, and smooth truck haul beds. Do not allow mixture to adhere to the truck beds. When directed by the Engineer, provide a cover that extends at least 1 ft [300 mm] over the truck bed sides and attach to tie-downs, if the truck is not equipped with a mechanical or automated covering system.

B.2.c Motor Graders

Use a motor grader with the following characteristics:

- (1) Self-propelled,
- (2) Equipped with pneumatic tires with a tread depth of $\frac{1}{2}$ in [13 mm] or less,
- (3) Equipped with a moldboard blade that is at least 10 feet [3 m], and
- (4) With a wheelbase of at least 15 feet [4.5 m].

B.2.d Distributor

Provide a distributor capable of uniformly applying material up to 15 ft [4.6 m] wide and equipped with the following:

- (1) An accurate volume measuring device with tachometer,
- (2) Pressure gauges,
- (3) Thermometer for measuring temperatures of tank contents,
- (4) Power-operated pump, and
- (5) Full circulation spray bars with lateral and vertical adjustments.

B.2.e Rollers

Compact each lift of asphalt to the density require in 2360.3.D, "Compaction."

B.2.e(1) Steel-Wheeled Rollers

Self-propelled steel wheeled compacting equipment must weigh at least 8 ton [7.3 tonne]. If using vibratory rollers, provide rollers that produce 3,085 lbf per ft [45 kN per m] of width and a vibratory frequency of at least 2,400 vpm using the low amplitude setting. Provide a roller capable of reversing without backlash and equipped with spray attachments for moistening rollers on both sets of wheels.

B.2.e(2) Pneumatic Tired Rollers

Self-propelled pneumatic tired compacting equipment must have a compaction width of at least 5 ft [1.5 m] and a gross wheel load force of at least 3,000 lb [13 kN] per wheel for traffic level 2 and level 3 mixtures, 5,000 lb [22 kN] per wheel for traffic level 4 and level 5 mixtures, and, if using vibratory, at least 8 ton [7.3 tonne] total mass. Provide a roller with a tire arrangement that obtains full compaction over the full width with each pass of the roller.



B.2.e(3) Trench Rollers

Self-propelled trench rollers must weigh at least 2,960 lb per foot [4,400 kg per meter] of width.

B.3 Tack Coat

Apply a uniform asphalt tack coat to the clean and dry existing asphalt or concrete surface and to the surface of each course or lift constructed, except for the final course or lift, in accordance with 2357. Coat the contact surfaces of all fixed structures and the edge of the in-place mixture in all courses at transverse joints and in the wearing course at longitudinal joints. Do not coat the longitudinal joint if a rubberized asphalt joint adhesive will be applied to the vertical face of the joint. A uniform application will not have streaks (corn rows), bare spots, puddles, or other irregular patterns. Allow emulsified asphalt tack coats to break, as indicated by a color change from brown to black, before placing subsequent lifts. Take tack samples from the asphalt distributor according to rates provided in the Material Control Schedule. The Inspector will monitor the sampling the Contractor performs.

C Joints

C.1 Construction Joints

Compact joints to produce a neat, tightly bonded joint that meets surface tolerances as described in 2360.3.E. Transverse and longitudinal joints are subject to the density requirement in accordance with 2360.3.D, "Compaction."

C.2 Transverse Joints

Construct a transverse joint, the full width of the paver, at right angles to the centerline when mixture placement operations are suspended. When work resumes, cut the end vertically for the full depth of the layer unless constructing a formed edge as approved by the Engineer.

C.3 Longitudinal Joint

Construct the longitudinal joint between strips and parallel to the pavement centerline. In multiple lift construction, construct the longitudinal joints between strips in each lift at least 6 in [150 mm] measured transversely from the longitudinal joints in the previously placed lift. If constructing a wearing course in an even number of strips, place one longitudinal joint on the centerline of the road. When constructing a wearing course in an odd number of strips, locate the centerline of one strip on the centerline of the road, provided that no joint is located in the wheel path area of a traffic lane. The Contractor will align longitudinal joints in multiple lift construction over portland cement concrete pavements directly over the concrete pavement longitudinal joints as approved by the Engineer.

At longitudinal joints formed by placing multiple strips, ensure the adjoining surface is higher but does not exceed $\frac{1}{8}$ in [3 mm], after final compaction of the previously placed strip. When constructing a strip

adjoining a previously placed strip or a concrete pavement, remove to the longitudinal joint line, any fresh mixture that overlaps a previously placed strip or pavement before rolling.

D Compaction

After spreading each course, compact in accordance with the maximum density method as described in 2360.3.D.1, unless the ordinary compaction method is called for in the special provisions or as described in 2360.3.D.2, "Ordinary Compaction." Do not allow rollers to stand on the uncompacted mixture or newly rolled pavement with a surface temperature greater than 140 °F [60 °C]. Do not roll with steel-wheeled rollers if rolling produces aggregate that is crushed, cracked, or pulverized or causes displacement of the mixture.

To maintain a true surface, correct the following by removing and replacing the material in the defective areas as directed by the Engineer at no additional cost to the Department:

- (1) Variations such as depressions or high areas, which may develop during rolling operations; and
- (2) Lean, fat, or segregated areas.

When spreading mixtures with a motor grader, compact the mixture with pneumatic tired rollers simultaneously with the spreading operation.

D.1 Maximum Density

Compact the pavement to at least the minimum required maximum density values in accordance with Table 2360-19, "Required Minimum Lot Density (Mat)," and Table 2360-20, "Longitudinal Joint Density Requirement." Density evaluation will include compacted mat density and compacted longitudinal joint density. Density evaluation will not include longitudinal joint density on lifts with a 1 percent reduced density requirement.

Table 2360-19 Required Minimum Lot Density (Mat)				
	SP Wear Mixtures*	SP Non-Wear Mixtures*	SP Shoulders*	
			Designed at 3% Voids	Designed at 4% voids
% Gmm	92	93	93	92
* Reduce the minimum by 1 percent on the first lift constructed over PCC pavements. Reduce the minimum by 1 percent for the first lift constructed on aggregate base (mainline and shoulder), reclaimed or cold in place recycled base courses and first lift of an overlay on roadway with a spring load restriction no greater than 7 ton [6.35 tonne], including shoulders.				

Table 2360-20 Longitudinal Joint Density Requirement



Location	Confined Edge of Mat*	Unconfined Edge of Mat
Long joint wear and shoulder (4% air voids)	89.5	88.1
Long joint non-wear and shoulder (3% air voids)	90.5	89.1
* The Department defines “confined” as the edges of the placed mat abutting another mat, pavement surface, or curb and gutter.		
The Department defines “unconfined” or “unsupported” as no abutment on the side of the mat being placed with another mat or pavement surface.		

D.1.a Shoulders Greater Than 6 ft [1.8 m]

Unless otherwise shown on the plans or required by the special provisions, compact shoulders wider than 6 ft [1.8 m] paved using the maximum density method. When shoulders are compacted by the maximum density method and are paved separately from the driving lane, or have a different required minimum density than the driving lane, delineate the lot tonnage placed on the shoulder in separate lots from the driving lanes for the day paving was conducted.

D.1.b Shoulders Equal to or Less Than 6 ft [1.8 m]

Unless otherwise shown on the plans or required by the special provisions, use the ordinary compaction method in accordance with 2360.3.D.2 to compact a narrow shoulder no wider than 6 ft [1.8 m] paved in the same pass as a driving lane or paved separately. The Department will exclude mixture compacted under ordinary compaction from lot density requirements and from incentive or disincentive payment.

When compacting a narrow shoulder using the maximum density method, compact to densities in accordance with Table 2360-19. If the minimum required density of the shoulder is different than the driving lane, delineate the tonnage placed on the shoulder in separate lots from the driving lane.

D.1.c Echelon Paving

The Department considers echelon paving, two pavers running next to each other in adjacent lanes, as separate operations.

D.1.d Density Determination (Core Bulk Density)

Calculate each individual lot's maximum density by averaging the results of the cores within the lot expressed as the percentage of the maximum specific gravity. Use Laboratory Test Method 1810 to determine core density unless the mixture is considered coarse graded. If 45 percent or less of the aggregate material passes the No. 4 [4.75 mm] sieve the Engineer may require bulk specific gravity be determined in accordance with Laboratory Manual Method 1816, Corelok.

Obtain the maximum specific gravity value for calculating the percentage density for the lot from the maximum gravity values taken from production tests during that day's paving. If the production tests during that day's paving result in only one or two maximum specific gravity values, use the moving average value at that

test point. If production tests during that day's paving result in three or more maximum specific gravity values, use the average of those tests alone as indicated above.

D.1.e Timeline

Complete compaction within 8 h of mixture placement and before obtaining core samples. Only use pneumatic tired or static steel rollers for compaction performed between 6 h and 8 h after mixture placement. Do not reroll compacted mixtures with deficient densities.

D.1.f Stop Production

If all the lots in a day's production or greater than 50 percent of the lots on multiple days fail to meet the minimum density requirement stop production and determine the source of the problem. Discuss with the Engineer what corrective action will be taken to bring the work into compliance with specified minimum required density.

D.1.g Lot Determination

Table 2360-21 Lot Determination	
Daily Production, ton [tonne]	Lots
300* – 600 [270* – 545]	1
601 – 1,000 [546 – 910]	2
1,001 – 1,600 [911 – 1,455]	3
1,601 – 2,600 [1,456 – 2,360]	4
2,601 – 4,600 [2,361 – 4,175]	5
> 4,600 [4,175]	
* If producing no greater than 300 ton [270 tonne] of mix, establish the first lot when the total weight is greater than 300 ton [270 tonne]. Add one lot for each additional 900 tons [820 tonne] or part thereof.	

D.1.h Mat Density Cores

Obtain four cores in each lot. Take two cores from random locations as directed by the Engineer. Take the third and fourth cores, the companion cores, within 1 ft [0.3 m] longitudinally from the first two cores. Submit the companion cores to the Engineer immediately after coring and sawing. If the random core location falls on a longitudinal joint, cut the core with the outer edge of the core barrel 1 ft [0.3 m] away laterally from the edge of the top of the mat. Do not take cores for compacted mat density within 1 ft [300 mm] of any longitudinal joint. The Contractor is responsible for maintaining traffic, coring, patching the core holes, and sawing the cores to the paved lift thickness before density testing.



The Engineer may require additional density lots to isolate areas affected by equipment malfunction, heavy rain, or other factors affecting normal compaction operations.

D.1.i Contractor Core Testing

Take and test cores at least 4 in [100 mm] in diameter at locations determined and marked by the Engineer.

Mark samples with the lot number and core number or letter. Transport the cores to the laboratory daily taking care to prevent damage to them. Schedule the approximate time of testing during normal project work hours to allow the Engineer to observe the test and to record the saturated surface dry and immersed weight of the cores.

Determine the density by the end of the next working day after compaction. Measure each core three times for thickness before saw cutting. Report the average lift thickness on the core sheet. If placing multiple layers in a single day, saw and separate cores for each layer, test, and report by the end of the next working day. Place and compact mix into the coring hole to restore the surface within 24 h after coring or the Department will fine the Contractor \$100 per working day per lot until restored.

D.1.j Companion Core Testing

The Department will select at least one of the two companion cores per lot to test for verification. For lots designated as longitudinal joint density lots, the Department will test at least one of the mat density companion cores and at least one of the longitudinal joint density companion cores.

D.1.k Tolerance Comparison

D.1.k(1) Tolerance Comparison – Individual

Compare the individual core bulk specific gravities obtained by the Contractor and by the Department. If the bulk specific gravity between the Contractor and the Department cores differ by more than 0.030, use the Department's bulk specific gravity.

D.1.k(2) Tolerance Comparison – Day's Shrinking Tolerance

For a second comparison of the cores that pass the individual tolerance criteria, compare the average of the Contractor's bulk specific gravities with the average of the Department's bulk specific gravities. Determine the tolerance by dividing 0.030 by the square root of the number of samples compared. Use all the Department's results for the day's paving if the cores do not fall within the determined tolerance.

D.1.l Recoring

The Engineer may allow the Contractor to re-core a sample if the sample was damaged in the coring process or damaged in transit to the laboratory through no fault of the Contractor.

D.1.m One Percent Reduced Density

The Department will exclude incentive payments for reduced minimum density in accordance with Table 2360-19, "Required Minimum Lot Density (Mat)." The Contractor may elect to waive the reduced density requirement and reevaluate the density in accordance with Table 2360-19, "Required Minimum Lot Density (Mat)," including incentives, for all cases except the first lift constructed over concrete pavement. The Contractor must notify the Engineer, in writing, after the first day's paving and by the end of the third day of paving of their intent to waive reduced density. Once reduced density has been waived the normal maximum density will remain in effect for the duration of mixture placement on that lift. For multi-year projects, the waiving of reduced density will be for that year only and will be re-evaluated for subsequent years on an annual basis. The Contractor is required to comply with any construction requirements on subsequent lifts.

D.1.n Longitudinal Joint Density

Evaluate longitudinal joint density in one lot per day unless the total daily weight is greater than 5,000 ton [5,000 tonne]. If the total daily weight is greater than 5,000 ton [5,000 tonne], evaluate two lots per day. Randomly select the location to take cores for longitudinal joint density from the mat density core locations. Take six cores at this location. Take cores for longitudinal joint density with the outer edge of the core barrel within 6 in [150 mm] from the edge of the top of the mat for both sides of the mat. Take a companion core 1 ft [0.3 m] longitudinally from each core. Take two cores for mat density at either 2 ft [0.61 m] right or 2 ft [0.61 m] left of the center of the mat the Contractor is paving, regardless of random number generation.

D.1.o Imaginary Joint

An actual longitudinal joint will not exist if pulling the shoulder and driving lane in the same paving pass. Do not cut a core on the imaginary line where a joint would have existed had the shoulder and the drive lane been paved separately.

D.1.p Shoulders**D.1.p(1) Shoulder – Ordinary Compaction**

If compacting the shoulder under the ordinary density specification, do not take longitudinal joint cores in shoulders. Core at the centerline longitudinal edge cores (6 in [150 mm] from the joint) and at the mat density cores (2 ft [0.61 m] right or left of the center of the paving pass).

D.1.p(2) Shoulder-Maximum Density Specification

Core at the following locations:

- (1) Centerline longitudinal edge cores (6 in [150 mm] from the joint),
- (2) Mat density cores (2 ft [0.61 m] right or left of the center of the paving pass), and
- (3) Edge of the shoulder (6 in [150 mm] from the outside edge).



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Do not cut cores on the imaginary line at the edge of the shoulder adjacent to the driving lane.
Move coring locations on imaginary lines to 6 in [150 mm] inside the edge of the shoulder.

D.1.q Payment Schedule

Table 2360-22 Payment Schedule for Maximum Mat Density			
SP Wear and SP Shoulders (4% Void) Density, %*	SP Non-Wear and SP Shoulders (3% Void), Density, %*	s 71.3 Mat Density Pay Factor A	
		s 71.4 Traffic c Level 2 & 3	s 71.5 Traffic c Level s 71.6 4 & 5
≥ 93.6	≥ 94.6	1.03	1.05
93.1 – 93.5	94.1 – 94.5	1.02	1.04
92.0 – 93.0	93.0 – 94.0	1.00	1.00
91.0 – 91.9	92.0 – 92.9	0.98	0.98
90.5 – 90.9	91.5 – 91.9	0.95	0.95
90.0 – 90.4	91.0 – 91.4	0.91	0.91
89.5 – 89.9	90.5 – 90.9	0.85	0.85
89.0 – 89.4	90.0 – 90.4	0.70	0.70
< 89.0	< 90.0	†	†



- * Calculate the percent of maximum specific gravity to the nearest tenth.
 - || Payment will only apply if the day's weighted average individual production air voids fall within - ½ percent of the target air void value. Base the weighted average air voids on all the mixture production tests in accordance with 2360.2.G.7, "Production Tests" for the corresponding day and weight by the tons the corresponding test represents.
 - † The Department will pay for the HMA material represented by the lot at 70 percent of the relevant contract unit price; unless a single core density in the lot is less than 87.0 percent of the maximum specific gravity (G_{mm}). If a single core density is less than 87.0 percent of G_{mm} , the Engineer will decide if the mixture is subject to removal and replacement or if will be accepted at a reduced payment of 50 percent of the relevant contract unit price. If the Engineer decides the material is to be removed and replaced, the Contractor will do so at no additional cost to the Department. Take additional core samples to determine the limits of the removal and replacement area or 50% payment using the same offset from centerline as the original core. If the original low density core was taken within 1½ ft [0.45 m] of an edge of the paver pass, take the additional cores at 1½ ft [0.45 m] from the edge of the paver pass. Determine the densities at 50 ft [15 m] intervals both ahead and behind the point of unacceptable core density until finding a point of acceptable core density (>89.0% for 4% void and 1% reduced voids and >90.0% for 3% voids). If the 50 ft (15 m) incremental testing extends into a previously accepted lot, removal and replacement may be required, but, these results will not be used to recalculate the previously accepted lot density. Perform the additional coring and testing at no cost to the Department. The Department will calculate the area of unacceptable pavement as the product of the longitudinal limits as determined by the 50 ft [15 m] cores and the full width of the paver pass, laying in the traffic lane or lanes. The Department will exempt shoulders from this calculation unless density failure occurred in the shoulder area.
- Establish an additional density lot for the pavement that has been removed and replaced. Cut 2 cores randomly with companions for the Department (total 4 cores) and determine average density. Make payment in accordance with Table 2360-22 or Table 2360-23 excluding any incentive payment.
- Determine the density for the remainder of the lot by averaging the original acceptable core density value with the first two acceptable core densities taken ahead and behind the unacceptable core density. Make payment in accordance with Table 2360-22 or Table 2360-23 excluding any incentive payment.

Table 2360-23*		
1 Percent Reduced Table		
SP Wear and SP Shld (4% Void) Maximum Specific Gravity, %	SP Non-Wear, and SP Shld (3% Void), Maximum Specific Gravity, %	Payment, %
≥ 91.0	≥ 92.0	100
90.0 – 90.9	91.0 – 91.9	98
89.7 – 89.9	90.5 – 90.9	95
89.4 – 89.6	90.0 – 90.4	91
89.2 – 89.3	89.5 – 89.9	85
89.0 – 89.1	89.0 – 89.4	70
< 89.0†	< 89.0	†
<p>* Reduce the minimum by 1 percent for the first lift constructed on aggregate base (mainline and shoulder), reclaimed or cold in-place recycled base courses and first lift of an overlay on a roadway with a spring load restriction (including shoulders) no greater than 7 ton [6.35 tonne]. Reduce the minimum by 1 percent on the first lift constructed on PCC pavements (reduced density cannot be waived on PCC).</p> <p> Calculate the percent of maximum specific gravity to the nearest tenth.</p> <p>† The Department will pay for the HMA material represented by the lot at 70 percent of the relevant contract unit price; unless a single core density in the lot is less than 87.0 percent of the maximum specific gravity (G_{mm}). If a single core density is less than 87.0 percent of G_{mm}, the Engineer will decide if the mixture is subject to removal and replacement or if it will be accepted at a reduced payment of 50 percent of the relevant contract unit price. If the Engineer decides the material is to be removed and replaced, the Contractor will do so at no additional cost to the Department. Take additional core samples to determine the limits of the removal and replacement area or 50% payment using the same offset from centerline as the original core. If the original low density core was taken within 1½ ft [0.45 m] of an edge of the paver pass, take the additional cores at 1½ ft [0.45 m] from the edge of the paver pass. Determine the densities at 50 ft [15 m] intervals both ahead and behind the point of unacceptable core density until finding a point of acceptable core density (>89.0% for 4% void and 1% reduced voids and >90.0% for 3% voids). If the 50 ft (15 m) incremental testing extends into a previously accepted lot, removal and replacement may be required, but, these results will not be used to recalculate the previously accepted lot density. Perform the additional coring and testing at no cost to the Department. The Department will calculate the area of unacceptable pavement as the product of the longitudinal limits as determined by the 50 ft [15 m] cores and the full width of the paver pass, laying in the traffic lane or lanes. The Department will exempt shoulders from this calculation unless density failure occurred in the shoulder area.</p> <p>Establish an additional density lot for the pavement that has been removed and replaced. Cut 2 cores randomly with companions for the Department (total 4 cores) and determine average density. Make payment in accordance with Table 2360-22 or Table 2360-23 excluding any incentive payment.</p> <p>Determine the density for the remainder of the lot by averaging the original acceptable core density value with the first two acceptable core densities taken ahead and behind the unacceptable core density. Make payment in accordance with Table 2360-22 or Table 2360-23 excluding any incentive payment.</p>		



Table 2360-24*

**Payment Schedule for Longitudinal Joint Density
(SP Non-wear and SP Shoulders, 4% Void)**

ongitudinal Joint (Confined Edge) Density, %	s 71.7 Pay Factor B Longitudinal (Confined Edge)		Longitudinal Joint (Unsupported Edge) Density, %	s 71.8 Pay Factor C s 71.9 (Unsupported Edge)	
	s 71.10 Traffic Level 2 & 3	s 71.11 Traffic Level 4 & 5		s 71.12 Traffic Level s 71.13 2 & 3	s 71.14 Traffic Level s 71.15 4 & 5
≥ 92.1	1.02†	1.03†	≥ 91.0	1.02†	1.03†
91.6 – 92.0	1.01†	1.02†	90.1 – 90.9	1.01†	1.02†
89.5 – 91.5	1.00	1.00	88.1 – 90.0	1.00	1.00
88.5 – 89.4	0.98	0.98	87.0 – 88.0	0.98	0.98
87.7 – 88.4	0.95	0.95	86.0 – 86.9	0.95	0.95
87.0 – 87.6	0.91	0.91	85.0 – 85.9	0.91	0.91
< 87.0	0.85	0.85	< 85.0	0.85	0.85

The Department will limit incentive payment for longitudinal joint density to lots with evaluated longitudinal joint densities.

Calculate the percent of maximum specific gravity to the nearest tenth.

Payment will only apply if the day's weighted average individual production air voids fall within - ½ percent of the target air void value. Base the weighted average air voids on all the mixture production tests in accordance with 2360.2.G.7, "Production Tests" for the corresponding day and weight by the tons the corresponding test represents.

Table 2360-25*

**Payment Schedule for Longitudinal Joint Density
(SP Non-wear and SP Shoulders, 3% Void)**

Longitudinal Joint (Confined Edge) Density, % ‖	s 71.16 Pay Factor B Longitudinal (Confined Edge)		Longitudinal Joint (Unsupported Edge) Density, % ‖	s 71.17 Pay Factor C s 71.18 (Unsupported Edge)	
	s 71.19 Traffic Level 2 & 3	s 71.20 Traffic Level 4 & 5		s 71.21 Traffic Level 2 & 3	s 71.23 Traffic Level 4 & 5
≥ 93.1	1.02†	1.03†	≥ 92.0	1.02†	1.03†
92.6 – 93.0	1.01†	1.02†	91.1 – 91.9	1.01†	1.02†
90.5 – 92.5	1.00	1.00	89.1 – 91.0	1.00	1.00
89.5 – 90.4	0.98	0.98	88.0 – 89.0	0.98	0.98
88.7 – 89.4	0.95	0.95	87.0 – 87.9	0.95	0.95
88.0 – 88.6	0.91	0.91	86.0 – 86.9	0.91	0.91
< 88.5	0.85	0.85	< 86.0	0.70	0.85

* The Department will limit incentive payment for longitudinal joint density to lots with evaluated longitudinal joint densities.

‖ Calculate the percent of maximum specific gravity to the nearest tenth.

† Payment will only apply if the day's weighted average individual production air voids fall within ½ percent of the target air void value. Base the weighted average air voids on all the mixture production tests in accordance with 2360.2.G.7, "Production Test" for the corresponding day and weight by the tons the corresponding test represents.

D.1.r Pay Factor Determination

Determine the pay factor in accordance with the following:

- (1) Case 1: Total Pay Factor = (Pay Factor A) × (Pay Factor B) × (Pay Factor C)
- (2) Case 2: Total Pay Factor = (Pay Factor A) × (Pay Factor B) × (Pay Factor B)
- (3) Case 3: Total Pay Factor = (Pay Factor A) × (Pay Factor C) × (Pay Factor C)

Where:

Pay Factor A = Mat density,

Pay Factor B = Confined edge density,

Pay Factor C = Unsupported edge density.

Use a pay factor of 1.00 for Pay Factor B, Pay Factor C, or both in lots where no cores are taken at the longitudinal joint.

D.2 Ordinary Compaction

Perform ordinary compaction for the following:

- (1) Layers identified in the typical sections with a minimum planned thickness less than 1½ in [40 mm],
- (2) Thin lift leveling,



- (3) Wedging layers,
- (4) Patching layers,
- (5) Driveways, and
- (6) Areas the Contractor cannot compact with standard highway construction equipment and practices.
- (7) Bike paths, walking paths, and other similar non-traffic paving areas

If using the ordinary compaction method to evaluate density, use a control strip to establish a rolling pattern. Use the rolling pattern to compact the asphalt mixture for the layer on which the control strip is constructed or until constructing a new control strip. The Engineer may waive the control strip requirement in small localized areas or other areas not conducive to its establishment.

D.2.a Control Strip

Construct a control strip at least 395 sq. yd [330 sq. m] and of the same thickness as the lift the control strip represents at the beginning of the work on each lift of each course. Begin compacting immediately after spreading the mixture. Continue compacting until additional roller coverage does not produce appreciable increase in density. Determine densities by means of a portable nuclear testing device or approved alternate and create a growth curve to determine the optimum rolling pattern. Provide documentation of the growth curve to the Engineer. Roll the remainder of that course in accordance with the pattern developed in the test strip for that roller. Provide a new control strip in accordance with the following:

- (1) If using a new JMF with a proportion change greater than 10 percent when compared to the currently produced mixture for a single stockpile aggregate,
- (2) If changing the source of either aggregate or binder, or
- (3) After 10 days of production.

D.2.b Equipment

Use rollers that meet the requirements in 2360.3.B.2.e. Use the same equipment type and weight on the remainder of the pavement course that was used to construct the control strip. Provide at least two rollers. Provide a tandem steel wheeled roller for final rolling. The Contractor may use trench rollers or mechanical tampers to compact areas inaccessible to the conventional type rolling equipment.

D.2.c Mixture Temperature

Refer to Table 2360-26, "Minimum Temperature Control" for the minimum laydown temperatures in all courses of the asphalt mixture as measured behind the paver or spreading machine. Do not pave when the air temperature is less than 32° F [0° C] unless otherwise directed by the Engineer in writing.

Table 2360-26*				
Minimum Temperature Control				
Air Temperature °F [°C]	Compacted Mat Thickness, †			
	1 in [25 mm]	1½ in [40 mm]	2 in [50 mm]	≥3 in [75 mm]
32 – 40 [0-5]	—	265[129]	255 [124]	250 [121]
41 – 50 [6-10]	270 [130]	260 [127]	250 [121]	245 [118]
51 – 60 [11-15]	260 [127]	255 [124]	245 [118]	240 [115]
61 – 70 [16-21]	250 [121]	245 [118]	240 [115]	235 [113]
71 – 80 [22-27]	245 [118]	240 [115]	235 [113]	235 [113]
81 – 90 [28-32]	235 [113]	230 [110]	230 [110]	230 [110]
≥ 91 [33]	230 [110]	230 [110]	230 [110]	225 [107]
* Not applicable if using a Warm Mix Asphalt (WMA) additive or process Use at least one pneumatic-tire roller for intermediate rolling unless otherwise directed by the Engineer. The Engineer may specify or modify the minimum laydown temperature in writing. † Based on the lift thicknesses shown on the plans.				

D.3 Mat Density Cores (Optional Department Only Core Testing)

The Contractor can request all density cores be tested by the Department. The written request should be made at the pre-construction meeting and a written response, from the Department, either approving or denying the request will be made within 5 calendar days from the date of the request. Once approval is granted, Department Only Core Testing will remain in effect for the duration of the project. For multi-year projects, Department core testing will be for that year only. Cores will be tested in either the Department's Field Lab or in the Contractor's Field Lab. The Contractor is permitted to observe and record all weighing of the cores.

D.3.a Contractor Coring Responsibilities

Obtain two cores in each lot. Take cores of at least 4 in [100 mm] in diameter at locations determined and marked by the Engineer. If the random core location falls on a longitudinal joint, cut the core with the outer edge of the core barrel 1 ft [0.3 m] away laterally from the edge of the top of the mat. Do not take cores for compacted mat density within 1 ft [300 mm] of any longitudinal joint. Label samples with the lot number and core number or letter. The Contractor is responsible for maintaining traffic, coring, patching the core holes.

Measure each core three times for thickness before saw cutting. Report the average lift thickness to the Engineer. If placing multiple layers in a single day, measure and record lift thickness and then saw and separate cores for each layer. Place and compact mix into the coring hole to restore the surface within 24 h after coring or the Department will fine the Contractor \$100 per working day per lot until restored.

The Engineer may require additional density lots to isolate areas affected by equipment malfunction, heavy rain, or other factors affecting normal compaction operations.



D.3.b Department Testing Responsibilities

The Department will take possession of the cores after they have been measured and cut. The Department will test all cores. Density results will be determined by the end day in which the cores were cut provided they are in the Department's possession by 10:00am, otherwise, results will be available the next working day. Test results will be reported on the Core Density Sheet.

D.3.c Longitudinal Joint Density

Evaluate longitudinal joint density in one lot per day unless the total daily weight is greater than 5,000 ton [5,000 tonne]. If the total daily weight is greater than 5,000 ton [5,000 tonne], evaluate two lots per day. Randomly select the location to take cores for longitudinal joint density from the mat density core locations. Take three cores at this location. Take cores for longitudinal joint density with the outer edge of the core barrel within 6 in [150 mm] from the edge of the top of the mat for both sides of the mat. Take one core for mat density at either 2 ft [0.61 m] right or 2 ft [0.61 m] left of the center of the mat the Contractor is paving, regardless of random number generation.

E Surface Requirements

After compaction, the finished surface of each lift shall be reasonably free of segregated, open and torn sections, and shall be smooth and true to the grade and cross section shown on the plans with the following tolerances:

Table 2360-26 Surface Requirements		
Course/Location	Description	Tolerance
Leveling/1 st lift using automatics	Tolerance also applies to 1 st lift placed other than leveling when automatics are used.	½ in [15 mm]
Wear	Tolerance of final 2 lifts from the edge of a 10 foot [3 m] straightedge laid parallel to or at right angles to the centerline.	¼ in [6 mm]
Shoulder Wear, Temporary Wear & bypasses	Tolerance from the edge of a 10 foot [3 m] straightedge laid parallel to or at right angles to the centerline.	¼ in [6 mm]
Transverse joints/construction joints	Tolerance from the edge of a 10 foot [3 m] straightedge centered longitudinally across the transverse joint. Correction by diamond grinding required when directed by the Engineer.	¼ in [6 mm]
Transverse Slope	Tolerance for surface of each lift exclusive of final shoulder wear.	Not to vary by more than 0.4 % from plans.

Distance from edge of each lift and established centerline.	No less than the plan distance or more than 3 inches [75 mm] greater than the plan distance. The edge alignment of the wearing lift on tangent sections and on curve sections of 3 degrees or less can't deviate from the established alignment by more than 1 inch [25 mm] in any 25 foot [7.5 m] section.	See Description
Final wear adjacent to concrete pavements.	After compaction the final lift wear adjacent to concrete pavements must be slightly higher but not to exceed 1/4" [6mm] than the concrete surface.	See Description
Final wear adjacent to fixed structures.	After compaction the final lift wear adjacent to gutters, manholes, pavement headers, or other fixed structures must be slightly higher but not to exceed 1/4" [6mm] than the surface of the structure.	See Description
Finished surface of each lift.*	Must be free of segregated and open and torn sections and deleterious material. *Excluding tight blade and scratch courses.	See Description

Cut or saw and then remove and replace material placed outside the described limitations at no additional cost to the Department. If the Engineer determines the material can remain in place outside the limits, the Department will pay for the material at a reduced cost of \$10 per sq. yd [\$12 per sq. m]. The Department will consider any single occurrence of material outside the limitations to have a minimum dimension of at least 1 sq. yd [1 sq. m] in any dimension.

In addition to the list the above the pavement surface must meet requirements of 2399 (Pavement Surface Smoothness) requirements.

E.1 Lift Thickness

After compaction, the thickness of each lift shall be within a tolerance of 1/4 in [6 mm] of the thickness shown on the plans, except that, if automatic grade controls are used, this thickness requirement will not apply to the first lift placed. This thickness requirement will not apply to a leveling lift whether or not automatic grade controls are required. The Engineer may require removal and replacement of any part of any lift that is constructed to less than the minimum required thickness, at no additional cost to the Department.

Measure cores taken for density determination for thickness also. Measure each core three times for thickness before sawing. Report the average of these three measurements. Document each lot's average core thickness and submit to the Engineer. If the average of the two Contractor cores exceed the specified tolerance, an additional two cores may be taken in the lot in question. The Engineer will use the average of all core thickness measurements per day per lift to determine daily compliance with thickness specifications.

On that portion of any lift constructed to more than the maximum permissible thickness, the materials used in the excess mixture above that required to construct that portion of the lift to the plan thickness plus 1/4 in [6 mm] may be excluded from the pay quantities or at the discretion of the Engineer and at the Contractor's expense may be required to be removed and replaced.



F Asphalt Mixture Production (FOB Department Trucks)

Produce asphalt mixture for the Department. Load the mixture being produced onto Department furnished trucks at the mixing plant at a time agreed on by the Engineer and Contractor. The Engineer will notify the Contractor of the total quantity of mixture required not less than 2 weeks prior to completion of the final wearing course. The Engineer will not accept the asphalt mixture if it is unsuitable for the intended use.

G Small Quantity Paving

A MDR is not required for planned project quantities less than 9,000 sq. yd inches (4,500 sq. yd per 2-inch thickness, etc) [191,200 m² mm] or 500 ton [450 tonne]. Verify in writing that the asphalt mixture delivered to the project meets the requirements of Table 3139-3 and Table 2360-7, "Mixture Requirements." The Department will obtain samples, as determined by the Engineer, to verify mixture requirements and to perform material acceptance in accordance with 2360.2.G.14.b, "Isolated Failures at Mixture Start-Up — Production Air Voids," 2360.2.G.14.c, "Individual Failure — Gradation, Percent Asphalt Binder, Production Air Voids, and Adj. AFT," and 2360.2.G.14.h, "Coarse and Fine Aggregate Crushing Failure."

2360.4 METHOD OF MEASUREMENT

When paying for material by weight, the Engineer will measure separately asphalt mixture of each type by weight based on the total quantity of material hauled from the mixing plant. The Engineer will not make deductions for the asphalt materials.

When paying for material by area, the Engineer will separately measure asphalt mixture of each type and for each specific lift by area and by thickness on the basis of actual final dimensions placed.

2360.5 BASIS OF PAYMENT

The contract unit price for asphalt mixture used in each course includes the cost of constructing the asphalt surfacing and providing and incorporating asphalt binder, mineral filler, hydrated lime. Anti-stripping additives may be permitted or required as indicated in 2360.2.C.

The Department will pay for additives required by the contract at the relevant contract unit price for the mixture. The Department will pay for additives incorporated as directed by the Engineer as extra work in accordance with 1403, "Extra Work."

The Department will apply reduced payment if the mixture includes steel slag as one of the aggregate proportions and the production lab density at the design gyrations at the recommended or established asphalt content is greater than 160 lb per cu. ft [2,565 kg per cu. m]. The Department will pay for the mixture at the contract unit price, calculated as follows:

$$\%Payment = \frac{100 - (100 \times (\text{production density at design gyrations} - 160))}{160}$$

$$\left[\%Payment = \frac{100 - (100 \times (\text{production_density_at_design_gyrations} - 2,565))}{2,565} \right]$$

If the plans do not show a contract pay item for shoulder surfacing and other special construction, the Department will include payment for the quantities of material used for these purposes in the payment for the wearing course materials.

Complete yield checks and monitor thickness determinations to construct the work as shown on the plans. Use the tolerances for lift thickness in accordance with 2360.3.E, "Surface Requirements" and surface smoothness requirements in accordance with 2399 for occasional variations and not for continuous over-running or under-running, unless otherwise required by the Engineer.

The contract unit price for asphalt mixture production includes the cost of the material and loading onto Department-provided trucks at the mixing plant.

The Department will pay for plant mixed asphalt pavement on the basis of the following schedule:

Item No.:	Item:	Unit:
2360.501	Type SP* Wearing Course Mixture †‡	ton [metric ton]
2360.502	Type SP* Non-Wearing Course Mixture †‡	ton [metric ton]
2360.503	Type SP* Course Mixture †‡# in [mm] thick,	square yard [square meter]
2360.504	Type SP* Course Mixture †‡	square yard [square meter]
2360.505	Type SP * Bituminous Mixture for Specified Purpose	ton [metric ton]
2360.506	Type SP * Bituminous Mixture Production	ton [metric ton]
*	Aggregate size Designation, 9.5, 12.5 or 19 as appropriate, see 2360.1.A.3.	
	"Wearing" or "Non Wearing" as appropriate.	
†	Traffic level in accordance with Table 2360-1, "Traffic Levels."	
‡	AC binder grade designation (Table 2360-2).	
#	Lift thickness shown on the plans.	

(2461) STRUCTURAL CONCRETE (2013 VERSION)

MnDOT 2461 shall be deleted and replaced with the following:

2461.1 DESCRIPTION

This work consists of producing, providing, placing, curing, and protecting portland cement concrete for placement in structures, pavements and incidental construction.

2461.2 MATERIALS

A Cementitious Materials

Provide cementitious materials from certified sources listed on the Approved/Qualified Products list.

Use Type I or Type I/II portland cement to produce Type 1 non-air-entrained concrete.

Use Type I or Type I/II portland cement and an air-entraining admixture listed on the Approved/Qualified Products List to produce Type 3 air-entrained concrete.

Use Type III portland cement as allowed by the Contract or the Engineer.

A.1 Portland Cement3101

A.2 Ground Granulated Blast Furnace Slag,3102

A.3 Blended Hydraulic Cement3103

A.4 Fly Ash3115

A.5 Cementitious Content

Provide concrete with the minimum cementitious content for the grades and slumps of concrete in accordance with Table 2461-1:



Table 2461-1 Minimum Cementitious Content, <i>lb per cu. yd [kg per cu. m]</i>								
Specified Slump Limit, in [mm]	Grades							
	U	V	W	X	Y	A	B	C
1 [25]	800 [475]	730 [435]	—	—	—	—	—	—
2 [50]	830 [490]	765 [455]	660 [390]	630 [375]	570 [340]	530 [315]	490 [290]	420 [250]
3 [75]	850 [505]	730 [475]	695 [410]	665 [395]	605 [360]	560 [335]	515 [305]	445 [265]
> 3 [75]	—	—	730 [475]	700 [415]	640 [380]	590 [350]	540 [320]	470 [280]

Except for grout mixtures, limit the maximum cementitious content for a cubic yard [cubic meter] of concrete to 850 lb [505 kg].

A.6 Cementitious Substitutions

The Contractor may replace Type I or Type I/II portland cement with other cementitious materials in accordance with the following restrictions:

- (1) Maximum of 15 percent substitution of Class C or Class F Fly Ash, on a one for one basis, by weight of the designed portland cement;
- (2) For Department designed mixes, the Department will adjust the batch weight of coarse aggregates to compensate for volume changes due to cementitious substitutions;
- (3) Maximum of 33 percent substitution of Class C or Class F Fly Ash for concrete pavement, on a one for one basis, by weight of the designed portland cement;
- (4) Maximum of 35 percent substitution of slag, on a one for one basis, by weight of the designed portland cement; and
- (5) Ternary mixes (portland cement and two other supplementary cementitious materials) are allowed when approved by the Engineer, in conjunction with the Concrete Engineer, or required by or allowed in the Contract.

B Fine Aggregate..... 3126

C Coarse Aggregate..... 3137

Unless otherwise required by the Contract, the Contractor may select the class of coarse aggregate as defined in 3137.2.B, "Classification."

D Water..... 3906

E Concrete Admixtures 3113

The Contractor may use the following admixtures listed on the Approved/Qualified Products List:

- (1) Type A, "Water Reducing and Mid Range Water Reducing Admixtures,"
- (2) Type B, "Admixtures Identified as Hydration Stabilizers,"
- (3) Type D, "Water Reducing and Retarding Admixtures"
- (4) Type S, "Viscosity Modifying Admixtures."

Use of any other admixtures in the concrete requires approval of the Concrete Engineer unless otherwise required by or allowed in the Contract.

When incorporating admixtures into the concrete:

- (1) Use admixture dosage rates recommended by the manufacturer.
- (2) Add all admixtures at the plant.
- (3) Provide admixture additions at the job site that are the same products as originally incorporated into the mix.
- (4) Use calcium chloride in concrete as approved by the Engineer, in conjunction with the Concrete Engineer. Do not use calcium chloride in units containing prestressing steel or in bridge superstructure concrete.

E.1 Use of Additional Admixtures

On a case by case basis, the Engineer, in conjunction with the Concrete Engineer, will consider the use of the following admixtures, added either at the plant or at the job site, as listed on the Approved Products list:

- (1) Type C, "Accelerating Admixtures"
- (2) Type E, "Water Reducing and Accelerating Admixtures"
- (3) Type F, "Water Reducing, High Range Admixtures"
- (4) Type G, "Water Reducing, High Range and Retarding Admixtures"

E.1.a Delivery Time Beyond 90 Minutes

If the haul time does not facilitate mixing and placing the concrete within 90 minutes, perform the following procedures for pre-qualifying a concrete mix to extend the delivery time to 120 minutes. Extending the delivery time beyond 120 minutes will require additional testing at 30 minute intervals up to the maximum desired delivery time as directed by the Concrete Engineer.

- (1) Provide a Contractor mix design in accordance with 2461.3G2 for each combination of materials.
- (2) Specification 2461.3D is modified to allow up to 25% fly ash replacement for cement. All other requirements of 2461 apply.
- (3) Laboratory trial batching on the proposed mix includes the following testing requirements:
 - (a) Perform all laboratory trial batching at an AMRL accredited laboratory.
 - (b) Perform all plastic concrete testing after adding all admixtures to the concrete mixture.
 - (c) Perform slump, air content, unit weight and temperature testing immediately after batching and at 90 and 120 minutes.
 - (d) Fabricate concrete cylinders for compressive strength at 90 and 120 minutes (sets of 3) and cylinders for hardened air content testing at 90 and 120 minutes (sets of 5).



- (e) Test the cylinders for compressive strength at 28 days.
 - (f) Determine the hardened air content (ASTM C457) at a minimum of 7 days. The Contractor is required to test at 2 samples representing 90 minutes and 2 samples representing 120 minutes and provide MnDOT with the other 6 samples for testing at their discretion. Retain any hardened concrete test specimens for a minimum of 90 days for MnDOT to examine at their discretion.
 - (g) Ensure the admixture manufacturer's technical representative is present during the trial batching.
 - (h) Contact the MnDOT Concrete Engineering Unit a minimum of 2 days prior to mixing. This same 2 day notification is required prior to any physical testing on hardened concrete samples.
 - (i) Once accepted by the Concrete Engineer, the laboratory trial batching is considered acceptable for use for 5 years, unless it is determined the material sources have changed significantly since the initial laboratory testing and acceptance. In all cases, the Engineer will require field trial batching on a project specific basis.
- (4) Field trial batching on the proposed mix for each specific project shall include batching in the presence of the Engineer and the following:
- (a) Provide a QC Plan for extending the delivery time beyond 90 minutes.
 - (b) Mix and transport the concrete using the same materials as were utilized in the laboratory trial batching.
 - (c) Batch a minimum 5 cu. yd (4 cu. m) of concrete utilizing the same methods intended for use when supplying concrete placed into the permanent work.
 - (d) Maintain the ready mix truck in transit; by either driving around the yard or on the roadway; and maintain the drum speed at 5 to 7 revolutions per minute for the entire 120 minutes.
 - (e) Perform all plastic concrete testing after adding admixtures to the concrete mixture.
 - (f) Perform slump, air content, unit weight and temperature testing at 90 and 120 minutes.
 - (g) Fabricate concrete cylinders for compressive strength at 90 and 120 minutes (sets of 3) and cylinders for hardened air content testing at 90 and 120 minutes (sets of 2).
 - (h) Test the cylinders for compressive strength at a minimum of 7 days.
 - (i) Determine the hardened air content (ASTM C457) at a minimum of 7 days. The Contractor is required to test 1 sample representing 90 minutes and 1 sample representing 120 minutes and provide MnDOT with the other 2 samples for testing at their discretion. Retain any hardened concrete test specimens for a minimum of 90 days for MnDOT to examine at their discretion.
 - (j) Incorporate the trial batch concrete into other work with the approval of the Engineer.
 - (k) The Contractor must demonstrate to the Engineer the ability to properly mix, control and place the concrete.
- (5) The Concrete Engineer, in coordination with the Engineer, will review the trial batch results and all related concrete testing for compliance with the QC Plan and the Contract. Final approval of the mixture is based on satisfactory field placement and performance.

F Concrete Mix Designs

F.1 Department Designed

The Department will provide the estimated composition of concrete mixes unless otherwise required by the Contract.

The Department may adjust the mix composition of the concrete without adjusting the Contract unit price for any Contract items.

F.1.a Concrete Yield

The Department defines concrete yield as the ratio of the volume of mixed concrete, less accountable waste, to the planned volume of the work constructed. The Department will not assume responsibility for the yield from a given volume of mixed concrete.

F.1.b High-Early Strength Concrete

When the Engineer requires high-early strength concrete, the concrete is designed in accordance with the following:

- (1) Increasing the cement content of the concrete up to 30 percent; using an approved accelerator as allowed by the Engineer, in conjunction with the Concrete Engineer; or both.
- (2) Using 100 percent portland cement, unless allowed by the Contract or the Engineer.
- (3) A maximum cement content for a cubic yard [cubic meter] of concrete not to exceed 900 lb [535 kg].
- (4) A water/cement ratio not to exceed 0.38 for Type 3 Concrete unless otherwise required by the Contract.

F.2 Contractor Designed

Design the concrete mix based on an absolute volume of 27.00 cu. ft \pm 0.10 cu. ft [1.000 cu. m \pm 0.003 cu. m] for the following:

- (1) Concrete paving mixes in accordance with 2301, "Concrete Pavement;"
- (2) Concrete mixes with an anticipated or required 28-day compressive strength of at least 5,000 psi [34 MPa];
- (3) Precast concrete in accordance with 2405, "Prestressed Concrete Beams," 2412, "Precast Concrete Box Culverts," 3236, "Reinforced Concrete Pipe," 3238, "Precast Concrete Box Culverts," 3621, "Concrete Masonry Units," 3622, "Sectional Concrete Manhole and Catch Basin Units," and 3630, "Precast Concrete Median Barriers;"
- (4) Colored concrete;
- (5) Stamped concrete;
- (6) Cellular Concrete Grout – Controlled Low Strength Material (CLSM);
- (7) Extended Delivery Times Beyond 90 minutes; and
- (8) Concrete as otherwise required by the Contract.

Submit the concrete mixes using the MnDOT Contractor Mix Design Submittal Package available on the Department's website at least 21 calendar days before initial placement of the concrete mix. The Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data for mix design calculations.

The Concrete Engineer, in coordination with the Engineer, will review the mix design submittal and will approve the materials and mix design for compliance with the Contract.



The Contractor assumes full responsibility for the mix design and performance of the concrete.

The Engineer determines final acceptance of the concrete for payment based on satisfactory field placement and performance.

F.3 Classification of Concrete

The Department will classify concrete by type, grade, consistency, and aggregate size. Refer to the mix number and Table 2461-2 to determine the mix requirements for each item of work.

Table 2461-2				
Mix Number Identification				
First Digit	Second Digit	Third Digit	Fourth Digit	Additional Digits
Type	Grade	Slump range	Coarse aggregate gradation range	Class A coarse aggregate when required, modified mix designation, or both

Refer to individual Contract items in the Standard Specification for Mix Numbers. Deviations from the specified Mix Numbers require coordination with the Concrete Engineer.

If the Contract does not show a concrete mix number, provide Type 3, Grade Y concrete with a slump and aggregate gradation determined by the Engineer.

The Department will designate grout by type and grade followed by the word "GROUT." Do not provide grout containing coarse aggregate. If the plans do not show a type or grade for grout, provide 3A GROUT.

F.3.a Type Designation

Provide Type 1 or Type 3 concrete in accordance with Table 2461-3:

Table 2461-3		
Concrete Type Designation		
Concrete Type	Target Air Content*, %	Maximum Water/Cement Ratio
1	2.0	≤ 0.53 for 1A43 ≤ 0.68 for 1C62 ≤ 0.64 for 1C Grout
3	6.5 †	≤ 0.45 † #
* For concrete mix design purposes only.		
The water/cement ratio is defined as the ratio of the total water weight to the total cementitious weight.		
† Unless otherwise required by 2301 or elsewhere in the Contract.		
#The maximum water/cement ratio for machine placed concrete is 0.42.		

F.3.b Grade Designation

The Department will designate concrete grade using a letter to represent the anticipated compressive strength and the minimum cementitious content in accordance with 2461.2.A.5, "Cementitious Content," and Table 2461-4:

Table 2461-4 Concrete Grade Designation		
Concrete Grade	Type 1 Anticipated Compressive Strength, <i>psi [MPa]</i> *	Type 3 Anticipated Compressive Strength, <i>psi [MPa]</i> *
U	6,300 [43]	5,600 [39]
V	6,000 [41]	5,300 [37]
W	5,700 [39]	5,000 [34]
X	5,400 [37]	4,700 [32]
Y	5,000 [34]	4,300 [30]
A	4,500 [31]	3,900 [27]
B	4,100 [28]	3,400 [23]
C	3,200 [22]	2,700 [19]
* Anticipated minimum strength produced in accordance with the Department specifications and cured for 28 days under laboratory conditions.		

The Concrete Engineer, in coordination with the Engineer, may increase the cement content for concrete with test cylinder results less than the anticipated compressive strength in accordance with Table 2461-4, "Concrete Grade Designation." The Contractor may request an increase in the cement content as approved by the Engineer, in conjunction with the Concrete Engineer.

F.3.c Slump Designation

Refer to the slump designation for the upper limit of the slump range without a water reducer in accordance with Table 2461-5:

Table 2461-5 Slump Designation	
Slump Designation	Slump Range without Water Reducer, <i>in [mm]</i>
1	½ – 1 [12 – 25]
2	1 – 2 [25 – 50]
3	1 – 3 [25 – 75]
4	2 – 4 [50 – 100]
5	2 – 5 [50 – 125]
6	3 – 6 [75 – 150]

F.3.d Coarse Aggregate (CA) Designation



Refer to the coarse aggregate designation for the range of optional coarse aggregates gradations allowed in the mix in accordance with Table 3137-4, "Coarse Aggregate Designation for Concrete," and Table 2461-6:

Table 2461-6	
Coarse Aggregate Designation for Concrete	
Range	Optional Coarse Aggregate Designation
0	CA-00 only
1	CA-15 to CA-50, inclusive
2	CA-15 to CA-60, inclusive
3	CA-35 to CA-60, inclusive
4	CA-35 to CA-60, inclusive
5	CA-45 to CA-60, inclusive
6	CA-50 to CA-70, inclusive
7	CA-70 only
8	CA-80 only

F.3.e Additional Designations

For mix designs that require a specified class of coarse aggregate as defined in 3137.2.B, "Classification," an additional letter will follow the fourth digit of the Mix Number such as "A" (Class A Aggregate Requirement).

The Engineer may identify special concrete mix designations with additional letters following the last digit such as "HE" (High Early), "WC" (Water/Cement Ratio), "HPC" (High Performance Concrete), "MS" (Microsilica), or others.

2461.3 CONSTRUCTION REQUIREMENTS

A Batching Equipment

A.1 Mixer Requirements

Provide stationary mixers or truck mixers.

A.2 General Condition

Maintain mixers as necessary to detect changes in condition due to accumulations of hardened concrete or mortar and examine to detect wear of blades.

Replace or recondition pickup and throwover blades in mixers with a rated capacity less than 14 cu. ft [0.40 cu. m] showing a blade wear loss of greater than $\frac{1}{2}$ in [13 mm], and pickup and throwover blades in mixers of greater capacity, showing a blade wear loss of no greater than $\frac{3}{4}$ in [19 mm] from the original factory dimensions.

A.3 Manufacturer's Rating Plate

Provide mixers that include the manufacturer's rating plate, showing the following information:

- (1) Serial number of the unit,
- (2) Mixing speed of the drum or paddles, and
- (3) Maximum capacity in terms of volume of mixed concrete.

A.4 Drum Speed for Stationary Mixers

Operate the drum speed in the mixer as specified by the manufacturer or as directed by the Engineer.

A.5 Auxiliary Equipment Requirements

Provide mixers equipped with the following:

- (1) Timing device,
- (2) Discharge locking device,
- (3) Water measuring device that operates mechanically and automatically during each batching cycle, and
- (4) A graduated adjustable indicator device to represent the volume of discharge in increments no greater than $\frac{1}{4}$ gal [1 L] in full view.

A.6 Mixer Capacity

Do not exceed the manufacturer's rated capacity of the mixer when mixing a single batch of concrete.

Batch concrete in volumes the mixer can accommodate without spilling, leaking, or segregating during the charging, mixing, or discharging operations. Provide mixers with a capacity of at least 1 sack [0.25 cu. m].

A.7 Mixing Time

The Department defines the mixing time as the time period beginning when the cement and aggregates enter the mixer drum and ending when the discharge begins.

Refer to the manufacturer's recommended minimum mixing time for single drum and dual drum mixers. In the absence of manufacturer's recommendation, the Engineer will designate the minimum mixing time. The minimum mixing time for any concrete batch is 60 s. The Contractor may reduce the manufacturer's recommended minimum mixing time or the Engineer designated mixing time if the Contractor obtains uniform mixing in accordance with 2461.3.E, "Mixing Requirements," and as approved by the Engineer, in conjunction with the Concrete Engineer.

If there is evidence of inadequately mixed concrete (unmixed or partially mixed materials) during concrete placement, the Engineer may direct an increase in the mixing time.

A.8 Turbine Type Mixers

Provide turbine type mixers meeting the applicable requirements for conventional type mixers (2461.3.A.1 through 2461.3.A.7) and in accordance with this subsection (2461.3.A.8). Maintain the mixer drum in a cylindrical shape within $\frac{3}{4}$ in [19 mm] from the original factory dimensions at any point. Maintain the mixer discharge gate in



a mortar tight condition in the closed position. Replace or recondition mixer paddles showing a wear loss greater than $\frac{1}{2}$ in [13 mm] from the original factory dimensions.

Add the mixing water to the batch materials in a manner that distributes the water to the inner or central areas of the drum. Start the flow of water before introducing the solid batch materials into the mixer drum.

During mixing, operate the paddles at a speed between 20 revolutions and 30 revolutions per minute. After adding the batch materials to the drum, mix the concrete for an additional 60 s.

A.9 Horizontal Axial-Revolving Blade Type Mixers

Provide horizontal axial-revolving blade type mixers in accordance with the applicable requirements for conventional type mixers (2461.3.A.1 through 2461.3.A.7) and in accordance with this subsection (2461.3.A.9).

Charge the water, aggregates, and cement in the sequence approved by the Engineer. Test the concrete uniformity as directed by the Engineer. The Engineer will use concrete uniformity tests to determine the minimum mixing time.

B Transportation Units

B.1 General Requirements

Equip transportation units intended for both mixing and agitating with watertight revolving drums mounted and powered and fitted with properly designed mixing blades in accordance with 2461.3.A.1 through 2461.3.A.7. Provide units capable of combining all the ingredients into a homogeneous mixture and designed to provide two drum speeds, one for mixing and the other for agitating. Provide units capable of delivering the concrete without segregation or loss of any of the batch materials.

Equip the mixer drum with a working counting device to record the number of revolutions.

Equip dump trucks and agitator trucks with vibrators to aid in discharge.

B.2 Capacity of Transportation Units

Refer to the truck mixer manufacturer's certification plate attached to the unit for the maximum capacity of the unit. If the unit will not satisfactorily mix the maximum volume shown, reduce the batch volume to allow proper mixing or discontinue use of the mixing unit as directed by the Engineer until the problem is corrected.

C Handling and Storing Materials

C.1 Batch Material Requirements

Do not change the source, kind or gradation of batch materials after the start of concrete production for the work unless otherwise approved by the Engineer. If the Engineer approves use of different material, completely exhaust the supply on hand before changing to the different material.

If delivering freshly washed aggregates to the batching plant, drain the aggregates for at least 12 h before using in the batching operation. If draining freshly washed aggregates at the site of the batching plant, completely

separate the drained material from the undrained materials, and provide for the disposal of water that accumulates from the drainage of materials.

Provide smooth, firm, and well-drained stockpile sites cleared of vegetable and extraneous matter. Where the natural foundation is unsatisfactory, as determined by the Engineer, construct the stockpiles on suitable platforms. Construct suitable bulkheads or partitions to separate different kinds of aggregate, gradation, or water content.

Construct stockpiles by methods that hold segregation and degradation to a minimum. If the Engineer sees segregation or degradation, the Engineer may designate that pile as unacceptable for use.

Do not use aggregates used to construct runways for loading or hauling equipment in concrete batches.

Use of aggregates from the bottom 1 ft [0.3 m] of a stockpile placed on an unprepared surface in concrete batches is allowed only under the Engineer's direct supervision and if the material meets all requirements of 3126, "Fine Aggregate for Portland Cement Concrete," and 3137, "Coarse Aggregate for Portland Cement Concrete."

Provide aggregates in accordance with the specified gradation requirements.

The Engineer will consider aggregates unacceptable if the variation in moisture content carried by any of the aggregates causes a marked variation in the consistency of successive batches of the mixed concrete, and will suspend operations until corrected.

C.2 Concrete Temperature Control

Produce concrete at temperatures from 50 °F to 90 °F [10 °C to 30 °C] and maintain temperatures until deposited in the work.

If necessary to maintain placement temperature, uniformly heat or cool the water, aggregates, or both, before introduction into the mixer. Control the temperature of the mixing water during heating or cooling.

Use aggregate at temperatures from 32 °F to 130 °F [0 °C to 55 °C]. Do not allow cementitious material to contact other batch material when the aggregate temperature exceeds 130 °F [55 °C].

Do not heat the cement, add salt, or add chemical admixtures to the concrete mix to prevent freezing.

Use a heating system to heat batch materials as approved by the Engineer. Do not use steam jets to spot heat the material as the work progresses.

Do not place mixer heaters intended for heating the batch materials in the mixer drum.

D Batching Requirements

Calibrate weighing equipment in accordance with 1901, "Measurement of Quantities." Inspect and calibrate the scales in accordance with the Concrete Manual.

D.1 Batching by Weight



D.1.a Proportioning Methods

Proportion concrete batch materials by weight in a central plant or by volume as directed by the Engineer, in conjunction with the Concrete Engineer.

D.1.b Weighing Equipment and Tolerances

Weigh or measure concrete mixture ingredients using load cells or meters for ready-mix and paving concrete to within the targeted batch weight in accordance with the following:

- (1) Water – 1 percent,
- (2) Cement – 1 percent,
- (3) Other cementitious materials – 3 percent,
- (4) Aggregates – 2 percent, and
- (5) Admixtures – 3 percent.

D.1.c Batching of Mixing Water

Measure the mixing water on scales or water metering devices containing the following:

- (1) A discharge indicator capable of being set to within 1 gal [5 L] of a predetermined quantity,
- (2) A positive automatic shutoff valve, and
- (3) An approved inspection seal on the scale or water metering device dating the time of the previous calibration and adjustment

An authorized service agency will calibrate the water meter every 6 months and make adjustments as necessary before use meeting the requirements of the weighing procedure in the Concrete Manual.

Check the water meter for accuracy at least once each month as the work progresses.

D.1.d Batching of Cementitious Materials

Weigh the cementitious material independently of the aggregates in separate compartments or on separate scales.

If the Contractor weighs the cement first and then separately records the weights of each individual cementitious material, the Contractor may weigh the cementitious materials cumulatively as approved by the Engineer, in conjunction with the Concrete Engineer.

D.1.e Batching of Aggregates

If the Contractor records each individual fraction weight of aggregates separately, the Contractor may weigh aggregates cumulatively as approved by the Engineer, in conjunction with the Concrete Engineer.

D.1.f Admixture Proportioning

If using two or more admixtures in a single concrete batch, add each admixture separately to prevent interaction of the different admixtures before mixing with other batch materials. Agitate admixtures to ensure homogeneous concentrations in accordance with the manufacturers recommendations.

Incorporate admixtures to the batch mix in liquid form. Maintain admixture solutions at a uniform concentration at all times. Use the solution concentration and proportions designated by the manufacturer.

If using a mechanical dispenser for proportioning Class I or Class II admixtures, provide a site gauge or meter. Have the admixture manufacturer check admixture dispensers yearly to determine accuracy and ensure unobstructed flow.

D.2 Batching by Volume

Proportion concrete for bridge deck overlays by volume or as required by the Contract.

If the Contractor calibrates the mixer for the specific batch materials in use, the Contractor may proportion concrete on other items of work by volume as approved by the Engineer in writing.

The Engineer will approve all methods and equipment used in volumetric proportioning.

Determine all material proportions and calibration settings on the basis of 100 lb [100 kg] of cementitious material.

Provide and use only sacked cement in the original mill containers unless the Contractor calibrates the mixer for the specific materials in use. Do not use fractional sacks.

Increase the cementitious content by 10 percent in the computation of volume proportions unless the Contractor calibrates the mixer for the specific materials in use.

E Mixing Requirements

The Engineer may check the water measuring equipment for accuracy before mixing operations begin and at any other time the Engineer considers necessary.

Mix concrete by one of the following methods:

- (1) A central plant (stationary plant),
- (2) Entirely or in part in truck mixers, or
- (3) At the construction site.

Do not allow the mixing batch to merge or intermix with the subsequent dry batch during mixing.

Discharge water remaining in the drums before batching.

Mix concrete to provide a mixture that is homogeneous and uniform in color. The Engineer will reject concrete batches that show a marked variation in consistency or evidence of improper mixing as unacceptable work



in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

After completely mixing the concrete, either in a central plant mixer or truck mixer, continuously agitate while in transit to the point of placement until the concrete is discharged from the unit, unless otherwise allowed by the Engineer, in conjunction with the Concrete Engineer.

If the mixing does not appear uniform, perform slump tests at the 15 percentage point and the 85 percentage points during unloading. If the results show a slump variation greater than 1½ in [38 mm], stop work and correct the mixing unit.

Produce concrete in such quantity and at such a rate as proper placement and finishing will permit. Do not re-temper partially set concrete.

Do not hand mix concrete.

E.1 Mixing In Truck Mixer

Charge the materials into the truck mixer drum by introducing sufficient water before adding solid materials. Perform charging operations without losing materials.

Leave the truck mixer at the plant site for a minimum of 5 min or 50 revolutions during the mixing period. Transport the concrete at agitating speed to the point of placement.

F Certified Ready-Mix Concrete

F.1 Definitions

The Department defines ready-mix concrete as one of the following:

- (1) Central-mixed concrete proportioned and mixed in a stationary plant and hauled to the point of placement in revolving drum agitator trucks or a truck mixer, or
- (2) Truck-mixed concrete proportioned in a stationary plant and fully mixed in truck mixers.

Table 2461-7 defines commonly used certified ready-mix terms.

Table 2461-7	
Certified Ready-Mix Terminology	
Term	Definition
Mix design water	The maximum allowable water content for 1 cu. yd [1 cu. m] of concrete in accordance with MnDOT Form TP 02406, <i>Estimated Composition of Concrete Mixes</i> .
Total moisture factor	Factor used to determine total amount of water carried by a given wet aggregate.
Absorption factor	Factor used to determine the water contained within the pores of the aggregate and is held within the particles by capillary force.

Free moisture	The water that is carried on the surface of the aggregate that becomes part of the total water.
Batch water	Water actually batched into the truck by the batcher.
Total water	Batch water added to free moisture. Total water may also include the water used in diluting admixture solutions.
Temper water	Water added in mixer to adjust slump.
Total actual water	The water in the concrete mixture at the time of placement from any source other than the amount absorbed by the aggregate. It includes all batch water placed in the mixer, free moisture on the aggregate and any water added to the ready mix truck prior to placement.
Ready-Mix Producer or "Producer"	Party that is producing the concrete for the Contract. It is understood that the Ready-Mix Producer is the agent of the Contractor.

F.2 General Requirements

Supply ready-mix concrete in accordance with 2461.3.F.3, "Certified Ready-Mix Plant Program."

The Engineer will reject ready-mix concrete delivered to the work site that does not meet the specified requirements for delivery time, consistency, quality, air content, or other properties as unacceptable work in accordance with 1512, "Unacceptable and Unauthorized Work."

Provide batches for a delivered load of concrete in sizes of at least 1 cu. yd [1 cu. m].

F.3 Certified Ready-Mix Plant Program

Provide ready-mix concrete produced by a certified ready-mix plant. Perform quality control of concrete production under a certification program for ready-mix concrete plants.

Complete all concrete plant documentation utilizing the Concrete Ready-mix Plant QC Workbook available from the MnDOT Concrete Engineering website. Electronically submit the QC Workbook to the Engineer by the Tuesday immediately following the previous week's production.

F.3.a Plant Certification

Before concrete production each season, ensure the producer performs the following:

- (1) Performs an on-site inspection at the concrete plant with the Engineer and completes a MnDOT Form 2163, *Concrete Plant Contact Report*.
- (2) Signs the report certifying compliance with the Certified Ready Mix requirements and continual maintenance of the plant. The Engineer will also sign MnDOT Form 2163, *Concrete Plant Contact Report*.
- (3) Provides a copy of the current Concrete Manual and retains it on-site.
- (4) Equips the Certified Ready-Mix Plant with a working facsimile machine or an email address.
- (5) Keeps plant reports, charts, and supporting documentation on file at the plant site for 5 calendar years.



- (6) Provides electronic scales for weighing all materials.

F.3.b Sampling and Testing

Provide a MnDOT Certified Concrete Plant Level 2 Technician to oversee testing and plant operations and to remain on-site during concrete production or have cellular phone availability.

Provide facilities in accordance with 1604, "Plant Inspection – Commercial Facility," for the use of the plant technician in performing tests.

Ensure the producer provides technicians with certification at least meeting MnDOT Concrete Plant Level 1 to perform all of the duties in accordance with the Concrete Manual. The Engineer will provide technicians with certification at least meeting MnDOT Concrete Plant Level 1 to perform all of the duties in accordance with the Concrete Manual.

Ensure the producer performs testing in accordance with the Concrete Manual and determines testing rates meeting the requirements of the Schedule of Materials Control. The Engineer performs testing in accordance with the Concrete Manual and determines testing rates meeting the requirements of the Schedule of Materials Control.

Take samples randomly using ASTM D 3665, Section 5.

Perform testing at the certified ready-mix plant site. Perform additional testing as directed by the Engineer. The Engineer may oversee the quality control sampling process.

Provide equipment and perform calibrations meeting the requirements of the following:

- (1) AASHTO T 27, "Sieve Analysis of Fine and Coarse Aggregates,"
- (2) AASHTO T 255, "Total Moisture Content of Aggregate by Drying,"
- (3) AASHTO M 92, "Wire-cloth Sieves for Testing Purpose," and
- (4) AASHTO M 231, "Weighing Devices Used in the Testing of Materials."

F.3.c Gradations

Determine the gradation of the fine aggregates and the coarse aggregates as required by the Contract. Use mechanical shakers for sieve analysis of fine and coarse aggregates.

Identify quality control companion samples with the following information:

- (1) Date,
- (2) Test number,
- (3) Time,
- (4) Type of material,
- (5) Plant, and
- (6) Sampling location.

Document gradation results on MnDOT Form 2449, *Weekly Concrete Aggregate Report*.

Chart all producer gradation results and Department verification gradation results of the coarse aggregate and the No. 8 [2.36 mm], No. 30 [600 μ m], and No. 50 [300 μ m] sieves of the fine aggregate.

The producer may request a reduction in testing rates as approved by the Engineer, in conjunction with the Concrete Engineer.

If the gradation tests on split samples from quality control or verification samples result in a variation between the producer and the Department greater than that set forth in Table 2461-8, the parties shall follow the procedures for test result dispute resolution available from the MnDOT Concrete Engineering website.

Table 2461-8	
Allowable Variations on Percent Passing Sieves	
Sieve Size	Allowed Percentage
2 in – 3/4 in [50 mm – 9.5 mm]	± 6
No. 4 – No. 30 [4.75 mm – 600 μ m]	± 4
No. 50 [300 μ m]	± 3
No. 100 [150 μ m]	± 2
No. 200 [75 μ m]	± 0.6

F.3.c.(1) Non-conforming Material

Only place concrete meeting the gradation requirements in the work. If the Contractor places concrete not meeting the gradation requirements into the work, the Engineer will not accept nonconforming concrete at the Contract unit price.

For concrete not meeting the required gradation, the Engineer will make determinations regarding the disposition, payment, or removal. The Department will adjust the Contract unit price for the concrete Contract item in accordance with Table 2461-9 and Table 2461-10. When there is not a separate *Structural Concrete* Contract unit price for an item of work or the concrete is a minor component of the Contract unit price, the Department will reduce payment based on a concrete price of \$100.00 per cu. yd [\$130.00 per cu. m] or the Contractor-provided invoice amount for the concrete in question, whichever is less.



Table 2461-9 General Concrete for Individual Aggregate Fractions Fine and Coarse Aggregate Specification Sieves other than Fine Aggregate No. 200 [75 µm]	
Outside of Specification, %	Adjusted Contract Unit Price
≤ 3	The Department will pay 98 percent of the relevant Contract unit price for concrete placed as approved by the Engineer.
4 – 6	The Department will pay 95 percent of the relevant Contract unit price for concrete placed as approved by the Engineer.
7 – 10	The Department will pay 90 percent of the relevant Contract unit price for concrete placed as approved by the Engineer.
> 10	The Department will pay 75 percent of the relevant Contract unit price for concrete placed as approved by the Engineer.

Table 2461-10 General Concrete for No. 200 [75 µm] Sieve of Fine Aggregate	
Outside of Specification, %	Adjusted Contract Unit Price
< 0.3	The Department will pay 98 percent of the relevant Contract unit price for concrete placed as approved by the Engineer.
0.4 – 0.6	The Department will pay 95 percent of the relevant Contract unit price for concrete placed as approved by the Engineer.
0.7 – 1.0	The Department will pay 90 percent of the relevant Contract unit price for concrete placed as approved by the Engineer.
> 1.0	The Department will pay for 75 percent of the relevant Contract unit price for concrete placed as approved by the Engineer.

If failure occurs on the fine aggregate No. 200 [75 µm] sieve and on other sieves concurrently, the Department will only reduce the price based on the larger percentage deduction.

The Engineer, in conjunction with the Concrete Engineer, will determine adjusted Contract unit prices for coarse aggregate quality failures in accordance with 1503, “Conformity with Contract Documents,” and 1512, “Unacceptable and Unauthorized Work.”

F.3.d Moisture Content

Ensure the producer performs the following:

- (1) Determines the moisture content using the oven-dry method in all fractions of the aggregate.
- (2) Documents moisture tests on MnDOT Form 2152, *Concrete Batching Report*.
- (3) Charts the moisture content of each aggregate.

In addition to the oven-dry moisture test, the producer may obtain the moisture content in the fine aggregate using a moisture probe.

To obtain approval for the use of a moisture probe, ensure the producer calibrates the moisture probe before each construction season meeting the requirements of the Concrete Manual. Ensure the producer verifies and charts both the probe moisture content and the oven-dry verification moisture test.

F.3.e Plant Diaries

Provide daily plant diaries in accordance with the Concrete Manual using an approved form from the MnDOT's Concrete Engineering website.

F.3.f Batch Weight Verification

The Engineer will observe the batching process to verify weights shown on the Certificate of Compliance.

The Engineer will observe the actual water batched during each collection of verification gradations in accordance with the following:

- (1) Watching the ready-mix truck reverse the drum after washing,
- (2) Verifying use of the current moisture test,
- (3) Verifying that any additional water added to adjust the slump is recorded, and
- (4) Validating water weights on the load batched and comparing the total water with the design water.

The Engineer will document the actual water batched on MnDOT Form 24143, *Weekly Certified Ready-Mix Plant Report* and submit a copy to the Engineer to provide to the Concrete Engineer.

The Engineer will provide plant diaries in accordance with the Concrete Manual.

F.3.g Certificate of Compliance

Provide a computerized Certificate of Compliance with each truckload of ready-mixed concrete at the time of delivery. The Department defines computerized to mean a document that records mix design quantities from load cells and meters.

If the computer that generates the Certificate of Compliance malfunctions, the Engineer may allow the Contractor to finish any pours in progress if the producer issues a handwritten MnDOT Form 0042, *Certificate of Compliance* with each load. Do not allow the producer to begin new pours without a working computerized Certificate of Compliance.

Provide a computerized Certificate of Compliance from the producer for each item of information, including the following:

- (1) Name of the ready-mix concrete plant.
- (2) Name of the Contractor.
- (3) Date.
- (4) State Project Number (SP) or (SAP).



- (5) Bridge Number (if applicable).
- (6) Time concrete was batched.
- (7) Truck number.
- (8) Quantity of concrete in this load.
- (9) Running total of each type of concrete, each day for each project.
- (10) Type of concrete (MnDOT Mix Designation Number).
- (11) Cementitious materials using MnDOT Standard Abbreviations.
- (12) Admixtures using MnDOT Standard Abbreviations.
- (13) Aggregate sources using 5 digit State Pit Numbers.
- (14) Admixture quantity in fluid ounces per 100 lb [milliliters per kilogram] or ounces per cubic yard [milliliters per cubic meter].
- (15) Batch information for materials using MnDOT standardized labels to represent each column in Table 2461-11. Present the information in the order listed across the page (a through k) or print the information using two lines provided that the materials are identified in each line of information.

Table 2461-11 Standardized Certificate of Compliance Labels			
	Formula Letter	Formula	Standard Label
a	Ingredients (aggregate, cementitious, water, admixtures)	—	Ingredient
b	Product Source (MnDOT Standard Abbreviation)b	—	Source
c	Total Moisture Factor (in decimals to 3 places)	—	MCFac
d	Absorption Factor (in decimals to 3 places)	—	AbsFac
e	MnDOT mix design oven dry (OD) weights, <i>lb/cu. yd [kg/cu. m]</i>	—	OD
f	Absorbed moisture in the aggregates, <i>lb/cu. yd [kg/cu. m]</i>	$(e \times d)$	Abs
g	Saturated surface dry (SSD) weights for aggregates, <i>lb/cu. yd [kg/cu. m]</i>	$(e + f)$	SSD
h	Free moisture, <i>lb/cu. yd [kg/cu. m]</i>	$(c - d) \times e$	Free Mst
i	Target weights for one cubic yard [cubic meter] of concrete, <i>lb/cu. yd [kg/cu. m]</i>	$(g + h)$	CY Targ [CM Targ]
j	Target batch weights, <i>lb [kg]</i>	$(cu. yd \times i)$ $[cu. m \times i]$	Target
k	Actual batch weights, <i>lb [kg]</i>	—	Actual
NOTE: Actual cubic yards [cubic meters] batched may vary due to differences in air content, weight tolerances, specific gravities of aggregates, and other variables.			

- (16) Total Water (Batch Water + Free Moisture) in pounds [kilograms].

- (17) Water available to add $[(\text{Mix Design Water}) \times (\text{Target CY (CM)}) - \text{Total water}]$ in gallons [liters].
- (18) Space to note the water adjustment information, including:
 - (18.1) Water in gallons [liters] added to truck at plant (filled in by producer, enter zero if no water is added).
 - (18.2) Water in gallons [liters] added to truck at the jobsite (filled in by producer or Engineer, enter zero if no water is added), and
 - (18.3) Total actual water in pounds [kilogram] (Total Water from Certificate of Compliance plus any additions).
- (19) The following information printed with enough room beside each item to allow the Engineer to record the test results:
 - (19.1) Air content,
 - (19.2) Air temperature,
 - (19.3) Concrete temperature,
 - (19.4) Slump,
 - (19.5) Cylinder number,
 - (19.6) Location or part of structure,
 - (19.7) Time discharge, and
 - (19.8) Signature of Inspector.
- (20) Location for the signature of the MnDOT Certified Plant 1 Technician representing the producer. The technician will review the first Certificate of Compliance for each mix type, each day, for accuracy and hand sign the Certificate of Compliance at a location designated for signature signifying agreement to the terms of this policy and to certify that the materials itemized in the shipment comply requirements of the Contract.

F.3.h Decertification

If the Contractor provides concrete from a plant that cannot produce concrete, fails to perform testing, fails to report accurate results, or fails to complete the required documentation, the Engineer may reject the concrete as unacceptable in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

The Concrete Engineer, with coordination from the Engineer, may decertify the plant and halt production of concrete if the producer performs the following:

- (1) Procedural changes made after the completion of the Concrete Plant Contact Report and after starting the work that cause non-compliance with the program,
- (2) Continually produces concrete in non-compliance with this section,
- (3) Completely disregards the requirements of this section, and
- (4) Submits fraudulent test reports.

If decertifying the plant, the Concrete Engineer may perform the following:

- (1) Revoke plant certification.
- (2) Revoke technician certification for individuals involved,
- (3) Revoke bidding privileges as determined by the Construction Engineer, and
- (4) Criminal prosecution for fraud as determined by the Attorney General.



G Concrete Placement

Do not produce concrete earlier than 60 min before the National Weather Service official sunrise, unless the Engineer approves otherwise.

Place concrete after the Engineer inspects and approves the foundation preparations, forms and falsework erection, placement of reinforcement steel, materials, equipment condition, and cold weather protection.

Do not place concrete if portions of the base, subbase, or subgrade layer are frozen, or if the excessive moisture levels make the grade unstable. Maintain the surface temperature above freezing for forms, steel, and adjacent concrete that will come in contact with the poured concrete before concrete placement.

Protect the concrete from freezing.

Protect the concrete against damage from construction operations or traffic.

Assume full responsibility for the acceptable production, placement, finishing, and curing of all concrete under the conditions prevailing, regardless of the restrictions imposed. Provide any artificial lighting, rain or cold weather protection necessary at no additional cost to the Department. The Engineer may subject any defects in concrete or concrete surfaces resulting from weather conditions, inadequate lighting, or other causes to 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

G.1 Notice of Inspection

Notify the Engineer at least 24 h before beginning concrete production to allow the Engineer time to provide inspection forces needed for the work and to approve preparations for concrete placement. If the Contractor fails to provide 24 h notice, the Engineer may delay concrete placement in accordance with 1503, "Conformity with Contract Documents" and 1512, "Unacceptable and Unauthorized Work."

If the producer needs to change plants during placement, notify the Engineer and obtain approval before changing the plant.

G.2 Placement Temperatures

Do not place concrete when the air temperature at the point of placement is below 36 °F [2 °C] or is expected to fall below 36 °F [2 °C] within the following 24 h period unless approved cold-weather provisions are in place. Discontinue concrete placement if the air temperature falls below 36 °F [2 °C].

Maintain concrete at a temperature from 50 °F to 90 °F [10 °C to 30 °C] until placement.

G.3 Delivery Requirements

Place concrete into the work in accordance with the following:

- (1) Type 1 Concrete—within 90 min of batching, and
- (2) Type 3 Concrete—within 90 minutes of batching when all admixtures are added at the plant at the manufacturer's recommended dosage rates listed on the Approved Products list. If the haul time does not facilitate mixing and placing the concrete within 90 minutes, test the concrete in accordance with 2461.3E1a.

The Contractor may transport Type 3 concrete in non-agitating equipment if the concrete is discharged within 45 min of batching.

Batch time starts when the batch plant or the transit mix truck adds the cement to the other batch materials.

G.4 Field Adjustments

Do not add additional mixing water once the concrete is 60 min old.

Mix the load a minimum of 5 minutes or 50 revolutions at mixing speed after addition of any admixture.

For concrete with slumps of greater than 1 inch (25 mm) do not make water adjustments after approximately 1 cubic yard (1 m³) is discharged.

For concrete with slumps of 1 inch (25 mm) or less, the Engineer will allow water adjustments as necessary to facilitate placement.

The Engineer will test the concrete for compliance with 2461.3.G.6, "Consistency," and 2461.3.G.7, "Air Content," in accordance with the following:

- (1) If the test taken by the Engineer passes, the Engineer will continue verification testing in accordance with the Schedule of Materials Control.
- (2) If the test taken by the Engineer fails, make adjustments and perform any quality control testing before the Engineer performs a final test. Acceptance or rejection of the truck is based on the Engineer's final test result.
- (3) The Engineer will test up to two additional trucks in accordance with items (1) and (2) above.
- (4) If the concrete does not meet the specification after those three trucks, the Engineer will reduce their verification testing rate to once per truck for acceptance for the remainder of the pour.

G.5 Test Methods and Specimens

The Engineer will furnish molds based on the maximum size aggregate for the test specimens in accordance with the following:

- (1) 4 in × 8 in [100 mm × 200 mm] cylinder molds,
- (2) 6 in × 12 in [150 in × 300 mm] cylinder molds for maximum aggregate sizes greater than 1 ¼ in [31.5 mm], and
- (3) 6 in × 6 in × 20 in [150 in × 150 in × 500 mm] beam molds and use other beam mold sizes as approved by the Engineer.

Provide curing tanks of adequate size and number for curing all of the concrete test specimens in accordance with 2031.3.C, "Special Requirements." Supply the curing tanks with heaters to maintain a water temperature of 73 °F ± 3 °F [23 °C ± 2 °C].

If Contractor testing is required by the Contract, perform the following:



- (1) Determine the required testing rates in accordance with the Schedule of Materials Control,
- (2) Take samples after the first ¼ cu yd [cu. m] and before discharging the last ¼ cu. yd [cu. m] of the batch,
- (3) Perform concrete sampling and testing meeting the requirements of the Concrete Manual,
- (4) Measure slump and air content, and make strength specimens when placing the concrete,
- (5) Record field measurements, including strength specimen identifications on MnDOT Form 2448, *Weekly Concrete Report*, to provide to the Concrete Engineer.

The Engineer will transport the cylinders to the Department's Laboratory for testing.

G.5.a Standard Strength Cylinders

The Department will perform the following for standard strength cylinders:

- (1) Cast cylinders for testing at 28 days,
- (2) Mark cylinders for identification of the represented unit or section of concrete,
- (3) Cure the cylinders meeting the requirements of the Concrete Manual, and
- (4) Submit cylinders and a completed cylinder identification card to the Department's Laboratory.

The producer of precast units is responsible for casting standard strength cylinders.

G.5.b Control Strength Cylinders

The Engineer will use control cylinders to determine when the sequence of construction operations is dependent upon the rate of concrete strength development. The Engineer will cast control cylinders to determine when the concrete attains the required strength for all desired control limitations. The Contractor is responsible for any additional control cylinders beyond the requirements of 2461.3.G.5.b (1).

The Department will perform the following for control strength cylinders:

- (1) Cast up to three (3) control cylinders.
- (2) Cure the cylinders in the same location and under the same conditions as the concrete structure or unit involved meeting the requirements of the Concrete Manual,
- (3) Mark control cylinders for identification of the represented unit or section of concrete, and
- (4) Submit cylinders and a completed cylinder identification card to the Department's Laboratory.

If the Department is unavailable to test the control cylinders, the Contractor shall submit the control cylinders to an independent testing facility for testing or perform the testing on the control cylinders on a portable mechanical or hydraulic testing machine checked and calibrated with a standard proving ring as approved by the Engineer and in the presence of the Engineer.

The producer of precast units is responsible for casting control strength cylinders.

G.5.c Strength Specimens for Concrete Paving

Use flexural beams to determine strength or provide cylinders as allowed by the Contract or approved by the Engineer.

Cast standard beams or cylinders for testing at 28 days.

Cast a sufficient number of control beams or cylinders to determine when the concrete attains the required strength for all desired control limitations.

Cure the standard beams or cylinders meeting the requirements of the Concrete Manual.

Cure the control beams or cylinders in the same location and under the same conditions as the concrete structure or unit involved meeting the requirements of the Concrete Manual.

The Engineer will test the flexural beams and record the results on MnDOT Form 2162, *Concrete Test Beam Data*.

If using cylinders, the Engineer will submit cylinders and a completed identification card to the Department's Laboratory.

G.6 Consistency

The Engineer will test the concrete for consistency using the slump test during the progress of the work. The Department may reject concrete batches with consistencies outside of the slump range in accordance with Table 2461-10. If any test shows the slump in excess of the upper limit of the slump range, the Engineer will reject the concrete represented by that test unless the Contractor makes adjustments to the concrete before use.

Adjust the slump within the allowable range to optimize both placement and finishing.

If not using a Department approved Type A water reducer at the manufacturer's recommended dosage rates listed on the Approved/Qualified Products List, meet the slump values for the slump range without water reducer in accordance with Table 2461-12.

If using an Department approved Type A water reducer at the manufacturer's recommended dosage rates listed on the Approved/Qualified Products List, meet the slump values for the slump range with water reducer in accordance with Table 2461-12.

Table 2461-12		
Slump Range Designation		
Slump Designation	Slump Range without Water Reducer, in [mm]	Slump Range with Water Reducer, in [mm]
1	½ – 1 [12 – 25]	½ – 1 [12 – 25]
2	1 – 2 [25 – 50]	1 – 3 [25 – 75]
3	1 – 3 [25 – 75]	1 – 4 [25 – 100]
4	2 – 4 [50 – 100]	2 – 5 [50 – 125]
5	2 – 5 [50 – 125]	2 – 6 [50 – 150]
6	3 – 6 [75 – 150]	3 – 7 [75 – 175]



Contact the Engineer if encountering unusual placement conditions that render the specified slump range unsuitable. The Department will provide mix composition modifications for Department designed mixes to provide the desired change in consistency while maintaining the other specified properties of the concrete mix. Do not add water solely to temporarily facilitate the placement of concrete.

G.6.a Concrete Placed by the Slip-Form Method

Place concrete that does not slough and is adequately consolidated at a slump value that optimizes placement for the designated mixture.

G.6.b Non-Conforming Material

Only place concrete meeting the slump requirements in the work. If the Contractor places concrete not meeting the slump requirements into the work, the Engineer will not accept non-conforming concrete at the Contract unit price.

For concrete not meeting the required slump, the Engineer will make determinations regarding the disposition, payment, or removal. The Department will adjust the Contract unit price for the Contract item of the concrete in accordance with Tables 2461-13, 2461-14, 2461-15 and 2461-16. When there is not a separate Contract unit price for *Structural Concrete* for an item of work or the concrete is a minor component of the Contract unit price, the Department will reduce payment based on a concrete price of \$100.00 per cu. yd [\$130.00 per cu. m] or the Contractor-provided invoice amount for the concrete in question, whichever is less.

Table 2461-13 General Concrete*	
Outside of Slump Range	Adjusted Contract Unit Price
Below slump range*	The Department will pay 95 percent of the relevant Contract unit price for materials placed as approved by the Engineer.
$\leq 1\frac{1}{2}$ in [40 mm] above slump range	The Department will pay 75 percent of the relevant Contract unit price for materials placed as approved by the Engineer.
$1\frac{1}{4}$ in [45 mm] – $2\frac{1}{4}$ in [55 mm] above slump range	The Department will pay 50 percent of the relevant Contract unit price for materials placed as approved by the Engineer.
$> 2\frac{1}{4}$ in [55 mm] above slump range	The Department will pay 25 percent of the relevant Contract unit price for materials placed as approved by the Engineer.
* If the Contractor places piling or footing concrete below the slump range, the Department will deduct \$100 per cu. yd [\$130 per cu. m] or the Contractor-provided invoice amount to the relevant Contract unit price of the concrete represented by the slump test, whichever is less. The Department will not reduce Contract unit price for low slump concrete placed with the slip-form method as approved by the Engineer.	

Table 2461-14 Bridge Deck Concrete	
Outside of Slump Range	Adjusted Contract Unit Price
Below slump range	The Department will pay 95 percent of the relevant Contract unit price for materials placed as approved by the Engineer.
$\leq 1\frac{1}{2}$ in [40 mm] above slump range	The Department will pay 75 percent of the relevant Contract unit price for materials placed as approved by the Engineer.
$> 1\frac{1}{2}$ in [40 mm] above slump range	The Department will pay 25 percent of the relevant Contract unit price for materials placed as approved by the Engineer.

Table 2461-15 Low Slump Bridge Deck Concrete From $\frac{1}{2}$ in to 1 in [12 mm to 25 mm]	
Outside of Slump Range	Adjusted Contract Unit Price
Below slump range	No deduction for materials placed as approved by the Engineer.
$\leq \frac{1}{2}$ in [12 mm] above slump range	The Department will pay 50 percent of the relevant Contract unit price for materials placed as approved by the Engineer.
$> \frac{1}{2}$ in – $\frac{3}{4}$ in [12 mm – 20 mm] above slump range	The Department will not pay for concrete placed but will allow the concrete to remain in place as approved by the Engineer.
$> \frac{3}{4}$ in [20 mm] above slump range	The Department will not pay for concrete. Provide additional testing as directed by the Engineer to determine if the concrete can remain in place or is subject to removal and replacement.

Table 2461-16 Low Slump Concrete — Patching From $\frac{1}{2}$ in to 1 in [12 mm to 25 mm]	
Outside of Slump Range	Adjusted Contract Unit Price
Below slump range	No deduction for materials placed as approved by the Engineer
$\leq \frac{1}{2}$ in [12 mm] above slump range	The Department will pay 75 percent of the relevant Contract unit price for materials placed as approved by the Engineer.
$\geq \frac{3}{4}$ in [20 mm] above slump range	The Department will pay 25 percent of the relevant Contract unit price for materials placed as approved by the Engineer.

G.7 Air Content

Maintain the air content of Type 3 general concrete at the specified target of 6.5 percent ± 1.5 percent of the measured volume of the plastic concrete in accordance with 1503, "Conformity with Contract Documents."



Make any adjustments immediately to maintain the desired air content.

Measure the air content at the point of placement but before consolidation.

G.7.a Non-Conforming Material

Only place Type 3 concrete meeting the air content requirements in the work. If the Contractor places Type 3 concrete not meeting the air content requirements into the work, the Engineer will not accept non-conforming concrete at the Contract unit price.

For concrete not meeting the required air content, the Engineer will make determinations regarding the disposition, payment, or removal. The Department will adjust the Contract unit price for the Contract item of the concrete in accordance with Table 2461-17. When there is not a separate Contract unit price for *Structural Concrete* for an item of work or the concrete is a minor component of the Contract unit price, the Department will reduce payment based on a concrete price of \$100.00 per cu. yd [\$130.00 per cu. m] or the Contractor-provided invoice amount for the concrete in question, whichever is less.

Table 2461-17	
General Concrete (Target Air Content 6.5%)	
Air Content, %	Adjusted Contract Unit Price
> 10.0	The Department will pay 75 percent of the Contract unit price for the concrete represented for material placed as approved by the Engineer.
>8.0 – 10.0	The Department will pay 95 percent of the Contract unit price for the concrete represented for material placed as approved by the Engineer.
5.0 – 8.0	The Department will pay 100 percent of the Contract unit price for the concrete represented, for material placed as approved by the Engineer.
>4.0 – <5.0	The Department will pay 75 percent of the Contract unit price for the concrete represented for material placed as approved by the Engineer.
>3.5 – 4.0	The Department will pay 25 percent of the Contract unit price for the concrete represented and placed as approved by the Engineer. If the Engineer, in conjunction with the Concrete Engineer, determines the surface is exposed to freeze-thaw cycling, coat the concrete with an approved epoxy penetrant sealer from the Approved/Qualified Products List.
≤ 3.5	Remove and replace concrete in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work," as directed by the Engineer. If the Engineer, in conjunction with the Concrete Engineer, determines the concrete can remain in place, the Engineer will not pay for the concrete and if the Engineer determines the surface is exposed to salt-brine freeze-thaw cycling, coat with an approved epoxy penetrant sealer from the Approved/Qualified Products List.

G.8 Allowable Testing Tolerances

Allowable tolerances are based on the results from two different testers and two different pieces of equipment from the same sample. Perform the test within the allowable tolerances in accordance with Table 2461-18.

Table 2461-18	
Allowable Testing Tolerances	
Test	Allowable Tolerance
Air content, % volume of concrete	1.0
Average slump:	
≤ 4 in [100 mm]	1.0 in [25 mm]
4 in – 6 in [100 mm – 150 mm]	1.5 in [38 mm]



Table 2461-18 Allowable Testing Tolerances	
Test	Allowable Tolerance
≥ 6 in [150 mm]	2.0 in [50 mm]
Unit weight, per cu. ft [cu. m], calculated to an air-free basis	1.0 lb/cu. ft [16 kg/cu. m]
Compressive strength 3,000 psi – 8,000 psi [20.6 MPa – 55.2 MPa], average of 3 tests	500 psi [3.4 MPa]

2461.4 METHOD OF MEASUREMENT

The Engineer will measure fresh concrete produced as required by the Contract by the theoretical volume. The Engineer will deduct accountable waste from the concrete measurement.

The Engineer will measure concrete mixtures on the basis of the dimensions of the structure shown on the plans. If the plans do not include a Contract item for concrete used in miscellaneous items, include the cost of the concrete with the relevant Contract items.

2461.5 BASIS OF PAYMENT

The Department will include the cost of the Certified Ready-Mix Plant Program with other relevant Contract items.

The Contract cubic yard [cubic meter] price for *Concrete, Mix No.* ____ includes the cost of production, placement, finishing, curing, and protection of concrete.

The Department will pay for structural concrete on the basis of the following schedule:

Item No.:	Item:	Unit:
2461.501	Concrete, Mix No. ____	cubic yard [cubic meter]